MAY 29 1939

ENGINEERING CONSTRUCTION WEEKLY

ENGINEERING NEWS-RECORD

MAY 25, 1939

Fabricated floor unit into place on the old Ohio River bridge at East Liverpool, Ohio.

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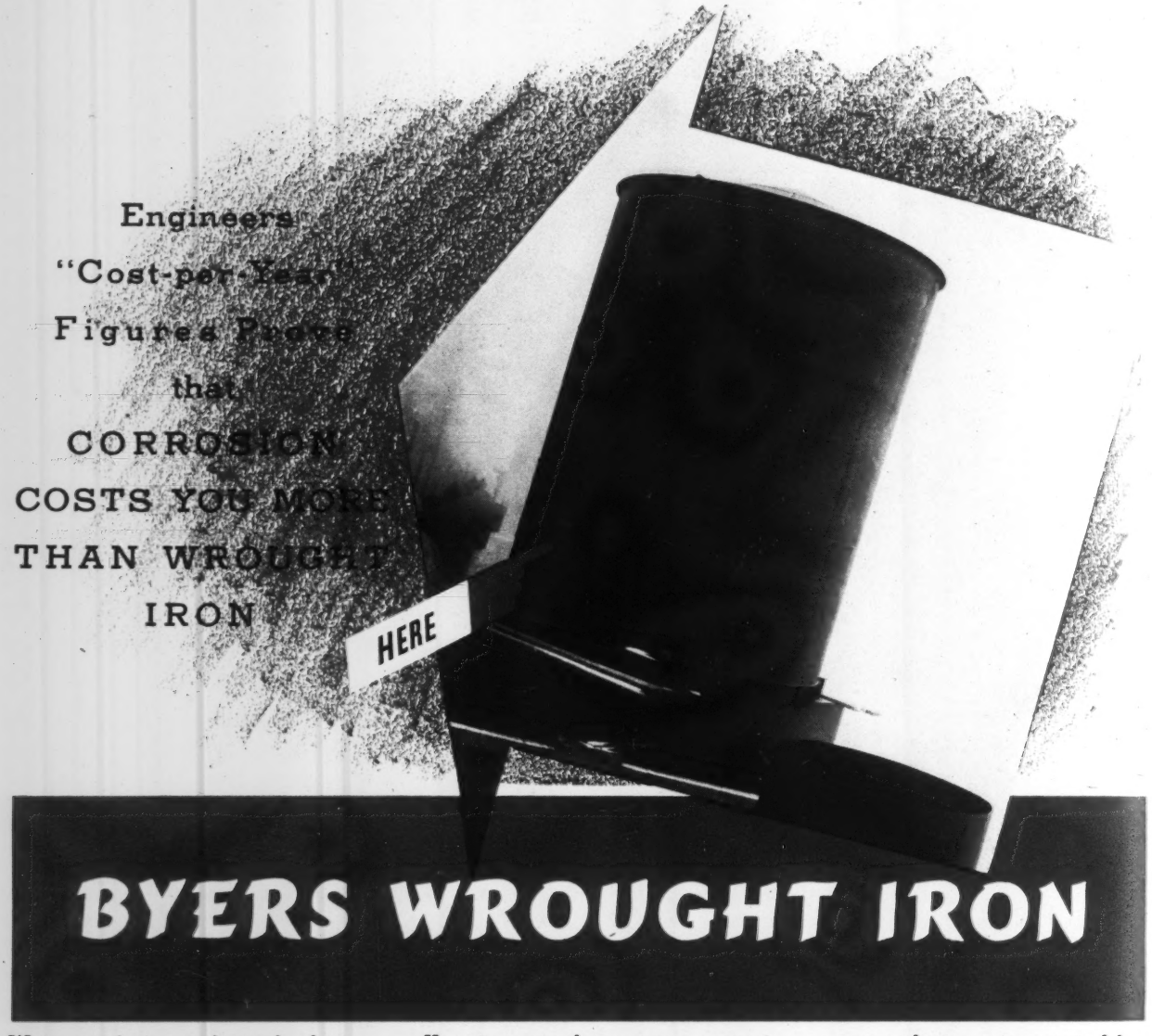

BYERS WROUGHT IRON

Water tanks at industrial plants frequently constitute a major maintenance problem, because they are exposed to corrosion within and without.

The plant engineer at the Coke Plant of the Hudson Valley Fuel Co., Troy, N.Y., seeking some material that would combine inherent permanence with proven corrosion resistance, replaced two existing tanks with a single new one of Byers Wrought Iron. The tank, illustrated above, is 13'8" x 18'2", with 21,000 gallon capacity. His selection was based on service data covering similar applications which showed that wrought iron costs *less* per year of service.

You, too, may have some corrosion problem where corrosion costs you more than wrought iron. If you will write, outlining your particular difficulty, our Engineering Service Department will (1) Determine the probable corrosive conditions involved; (2) Relate these to similar conditions encountered elsewhere; (3) Interpret the results in the light of 75 years' contact with all corrosion problems . . . and (4) Make recommendations, supported by service records. To see for yourself the wide variety of tank problems that wrought iron is successfully solving, ask for a complimentary copy of our bulletin, "Wrought Iron for Tank Construction."

A. M. Byers Co., Pittsburgh, Pa. Established 1864. Boston, New York, Philadelphia, Washington, Chicago, St. Louis, Houston, Seattle, San Francisco.

BYERS GENUINE WROUGHT IRON

TUBULAR AND FLAT ROLLED PRODUCTS

Specify Byers Genuine Wrought Iron Pipe for corrosive services and Byers Steel Pipe for your other requirements

ENGINEERING NEWS-RECORD

Devoted to Buildings, Sewers, Waterworks, Bridges, Highways, Streets, Dams, Foundations, Earthwork, Flood Control, Public Works, Irrigations, Canals, Railroads

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THIS WEEK

• Radio, as a new industry, has given engineers and contractors important new things to do. An outstanding example is the new building for National Broadcasting Co. in Hollywood. Apparently a single building, it is actually made up of eight units structurally separate for acoustical and earthquake safety reasons.

• Rebuilding bridge floors under traffic has always been a source of trouble for bridge engineers. A radically new method of so doing the job is reported on p. 54 of this issue.

• Valuable information for contractors who have to plan and direct blasting work is contained in John Jeffries' article on blasting procedure.

• Engineers concerned with river control will find valuable data in C. R. Martin's terse presentation of an improved design for roller gates, a type of control structure that is gaining in recognition.

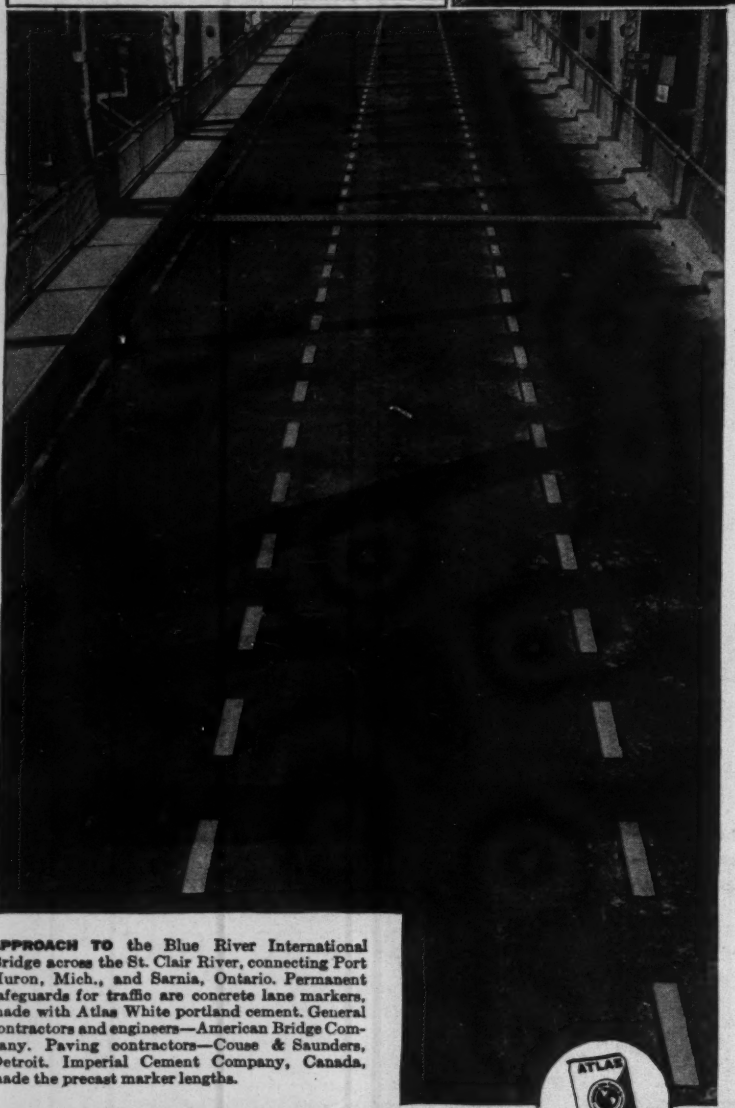
• Turning from the economic and climatic problems of water-power development in Nebraska that were discussed in the issue of April 27, V. T. Boughton reviews the physical problems of that unusual work and tells what the engineers have done to minimize the effect of the troubles they encountered.

THINGS TO COME

• Measured by money spent for new construction as well as by progress in technical developments the waterworks industry has entered a new era of accomplishment. First quarter statistics compiled by Engineering News-Record show a 520 per cent gain in waterworks expenditure over a comparable period last year when all records were broken!

This tempo of the times is reflected in the June 8 Waterworks Issue which will contain nine major articles on present developments in design and operation. New information is made available on automatic pumping control, water softening, main sterilization, distribution design, and pipe location with radio finders.

Over this Blue Water International Bridge to Canada



APPROACH TO the Blue River International Bridge across the St. Clair River, connecting Port Huron, Mich., and Sarnia, Ontario. Permanent safeguards for traffic are concrete lane markers, made with Atlas White portland cement. General contractors and engineers—American Bridge Company. Paving contractors—Couse & Saunders, Detroit. Imperial Cement Company, Canada, made the precast marker lengths.

TWO DOTTED LINES OF WHITE CONCRETE

are permanent traffic guides

WHEN the King and Queen of England dedicate this highway link between the United States and Canada, they will see a structure that possesses outstanding factors of safety.

Motorists who travel over this cantilever crossing are now appreciating one important safety feature—traffic *markers* of white concrete. Exposed to every whim and onslaught of the weather, these markers, made with Atlas White portland cement, will keep their whiteness. Their hard, white surface will never require painting, repairing or replacing. Precast in short lengths, they were easy to install. And they will be permanent guides to traffic.

More and more highway and safety officials are deciding today that it pays to use markers (and curbing) made with white concrete. They are learning that this is one sure way to eliminate maintenance costs, keep traffic running smoothly, and reduce accidents. Universal Atlas Cement Co. (United States Steel Corporation Subsidiary), Chrysler Building, New York City.

NR-M-4

ATLAS WHITE PORTLAND CEMENT FOR MARKERS AND CURBS

ENGINEERING NEWS-RECORD

NEWS

Volume 122 MAY 25, 1939 Number 21

New York Passes Housing Law

State will make loans and grants for low cost housing to local communities

The first state-financed housing program in the country became effective last week when the New York State legislature passed a bill implementing the housing program provided in the constitutional amendment approved by voters last November (*ENR*, Nov. 17, 1938, p. 603).

Following generally the pattern of the federal USHA program, the new measure provides for the immediate issuance of $50,000,000 in bonds with an additional $100,000,000 to be issued in the near future. The proceeds will be loaned to New York State communities

(Continued on page 47)

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Authorization Refused For Florida Canal

The Senate on May 17 refused to authorize the $200,000,000 Florida Ship Canal. By a vote of 36 to 45 it defeated a bill which would have authorized the canal, subject to a restriction that tolls be charged and that the President submit a proposed schedule of toll charges before work is resumed.

Opposition to the bill was expressed in the Senate mainly on the ground of economy.

CONSTRUCTION ACCIDENT ON EVERETT, WASH., SCHOOL BUILDING

STEELWORK of part of an auditorium-gymnasium under construction at Everett, Wash., collapsed May 19 when the last of five 113-ft. trusses, which was being swung into place by a derrick, struck an already-erected truss. The spans had not yet been braced, and the span which was struck swayed violently and slowly collapsed, carrying with it two adjoining spans.

Contractors declare that the steel took three minutes to settle to the floor, hardly chipping the concrete and giving workmen ample time to escape.

The structure is being built for the Everett school board by the Brady Construction Co. of Seattle; the subcontractor for the steelwork is Pacific Car & Foundry Co. of Seattle. It was financed with a PWA grant.

Denison Dam Plans Approved

Height of rolled fill dam is lowered twenty-five feet, reducing cost about $3,000,000

Plans for the proposed Denison Dam, a flood control and hydro-electric project to be constructed on the Red River near Denison, Texas, have been approved by Major General Julian L. Schley, Chief of Engineers, it has been announced by Capt. Lucius D. Clay, district engineer in charge of the project. The revised plans reduce the originally planned height of 190 ft. to 165 ft., bringing the total cost of the project to $50,800,000 instead of the original $54,000,000.

Denison Dam is listed by the Chief of Engineers as one of the projects on which he expects to spend part of the 1939-40 flood control appropriation, which has passed the House and is waiting action in the Senate.

The reduction in height, presumably a result of local protests as to the amount of land to be inundated by the reservoir, reduces the amount of railroad relocation to 28.5 miles instead of 64.03. The reservoir area at the revised spillway height will be 127,000 acres, of which 35,900 will be in Texas and 91,700 in Oklahoma. The total storage below the spillway crest will be 5,825,000 acre-ft., of which 2,060,000 will be devoted to power regulation, dead storage will take 1,020,000, and the remainder will be devoted to flood control. An additional 758,000 acre-ft. of storage is available with a 5-ft. surcharge above spillway level.

The reservoir is designed completely to control the record flood of 1908 with a peak discharge of 470,000 sec.-ft. The spillway is designed for a peak outflow of 750,000 sec.-ft.

The dam is to be a rolled earth fill 14,000 ft. long with a top width of 40 ft., maximum base width of 1,145 ft. and volume of 15,475,000 cu.yd. The impervious upstream section will have slopes ranging from 1 on 2.5 to 1 on 4; downstream slopes will be 1 on 2 and 1 on 3.

Kansas City Books To Be Audited

Political spending investigation results in hiring of special auditing firm

Stemming from a federal indictment of political leader T. J. Pendergast for income tax evasion, a grand jury investigation of the ramifications of boss control government in Kansas City, Mo., has uncovered so many questionable practices that a committee of business men, with the support of the mayor, has hired a firm of accountants to audit the books of the city and of Jackson County in which it is located. The firm is that of George Rossetter & Co., which made a similar audit for Chicago and Cook County.

H. F. McElroy, city manager for thirteen years, resigned about the middle of April and his place has been filled by Eugene C. Zachman who with Mayor Bryce B. Smith is revamping city buying and contracting practices as well as making extensive changes in city personnel.

Construction dominated

Pendergast, whose plea of guilty to the income tax charge on May 23 resulted in a fine and a prison sentence, has for years dominated construction work in Kansas City, not only through control of patronage in city departments but through his own construction and materials companies. Among them are said to be Ready-Mixed Concrete Co., Midwest Paving Co., Midwest Pre-Cote Co., Kansas City Concrete Pipe Co., Centropolis Crusher Co., W. A. Ross Construction Co., Public Service Pulverizing Co., and Public Service Quarries Co. A sensational development, following his testimony before the grand jury, was the suicide on May 1 of Edward L. Schneider, secretary-treasurer of a half dozen of the above companies.

Big projects affected

Points that are being investigated are that the city has paid $342,500 for water line leak surveys to a firm headed by a man now employed in a water department survey crew; that funds in large amounts were passed through a "city manager's emergency account" without record; that funds from a Ten Year Improvement Plan bond issue have been used on projects not properly included, such as a sewer tunnel and the Fifteenth St. Viaduct, both of which are under construction. The bond issue has already provided, with PWA and WPA help, a city hall, an auditorium, a new water plant and important traffic way improvements.

TYLER TO HEAD MISSISSIPPI WORK

BRIG. GEN. MAX C. TYLER, who has been serving since July 31, 1936, as Assistant Chief of Engineers, has been designated as president of the Mississippi River Commission. He succeeds Brig. Gen. Harley B. Ferguson, who will reach the retirement age Aug. 14.

Appointment of Gen. Tyler to head the Mississippi River Commission is not expected to result in any major change in policy. He is known to favor the use of cutoffs to reduce flood heights in the middle sector of the Mississippi River and has been closely associated with General Ferguson's plans in his present position.

Gen. Tyler has been connected with the Army service since he entered the U. S. Military Academy in 1899.

Two States Cooperate On Toledo Bypass

Cooperation between the state highway departments of Ohio and Michigan in the development of a bypass route around the city of Toledo by the improvement of U. S. Route 25 in Michigan and state Route 575 in Ohio was agreed to last week at a conference between Murray B. Van Wagoner and Robert S. Beitler, heads, respectively, of the Michigan and Ohio highway departments.

Under the agreement, the Ohio highway department will build a bridge over the Ottawa River, on which it is expected to advertise for bids within six weeks, and build about a mile of connecting highways next spring. The Michigan department will start next spring to pave 20 miles of Route 25.

LABOR NOTES

THE NATIONAL Labor Relations Board has ordered the Chicago Apparatus Co., to stop discouraging membership in the Federation of Architects, Engineers, Chemists and Technicians, Local 107, CIO, and to reinstate three employees with back pay. The finding said that the federation apparently represented a majority of the employees in June 1937 and thereafter, but that the company had refused to bargain collectively. The company claims that the union had not proved its right to represent the employees, but NLRB found that the company had attacked the union through distribution of literature and through statements by supervisory employees. The board therefore dismissed the union's request for an election and ordered the company to bargain with the union, pointing out that "to do otherwise would be to hold that the freely expressed wishes of the majority of employees could be flouted if the employer exercised sufficient coercion to undermine the union's majority status."

UNORGANIZED workers on the South Penn toll road in Pennsylvania, who last month forced the County Construction Co., a contractor on the toll road, to abrogate a closed shop contract with the AFL laborers' union and operate on an open shop basis (*ENR*, May 4, 1939, p. 7), have now formed an organization, the Somerset Independent Workers Association, and have signed closed shop agreements with the County Construction Co. and also with the Connell & Laub Co., another turnpike contractor.

COMMON LABORERS in the Tri-City area of Iowa and Illinois, on strike since May 1, went back to work May 17 with their pay rate increased from 65 to 70 cents an hour for all projects contracted for after May 1.

CONSTRUCTION of a number of building projects at Colorado educational institutions has been seriously delayed by a strike of brick and tile workers in Denver and northern Colorado, who have been out on strike for the past seven weeks.

• • •

Misplaced Air Base

The Naval air base pictured in our issue of May 11, p. 48, was incorrectly described as being at San Francisco. Actually the naval air station is at Alameda, Calif. A further error was the description of the lagoon as being 1,300 ft. wide; it is 1,600 ft. wide.

River-Harbor Bill Cut in House

Umatilla Dam and Tennessee-Tombigbee Canal dropped from authorization measure

The House of Representatives on May 18 authorized construction of river and harbor projects to cost $83,728,100. Dropped from the bill were a $12,500,000 preliminary authorization for a $73,000,000 canal to connect the Tennessee River with the Tombigbee River and a $23,700,000 authorization for construction of the Umatilla Dam on the Columbia River between Grand Coulee and Bonneville dams. Both these projects had been recommended by the House committee on rivers and harbors.

Among the larger projects authorized in the bill are the following:

New Jersey Intracoastal Waterway	$2,100,000
Winyah Bay, S. C.	1,260,000
Warrior and Tombigbee Rivers, Ala. and Miss.	12,500,000
Mississippi River, La.	4,200,000
Louisiana–Texas Intracoastal Waterway	5,200,000
Houston Ship Channel	3,696,000
Guadalupe River, Texas	8,500,000
Mississippi River between Ohio and Missouri	10,290,000
Calumet-Sag Channel and Indiana Harbor and Canal, Ill. and Ind.	25,900,000
Missouri River, Sioux City to mouth	6,000,000
Oswego Harbor, N. Y.	1,000,000
Sacramento River flood control (additional)	1,600,000
Wrangell Narrows, Alaska	2,731,000

The House turned down an amendment to authorize construction of a dam in the Connecticut River at Enfield, Conn., to cost $12,344,000.

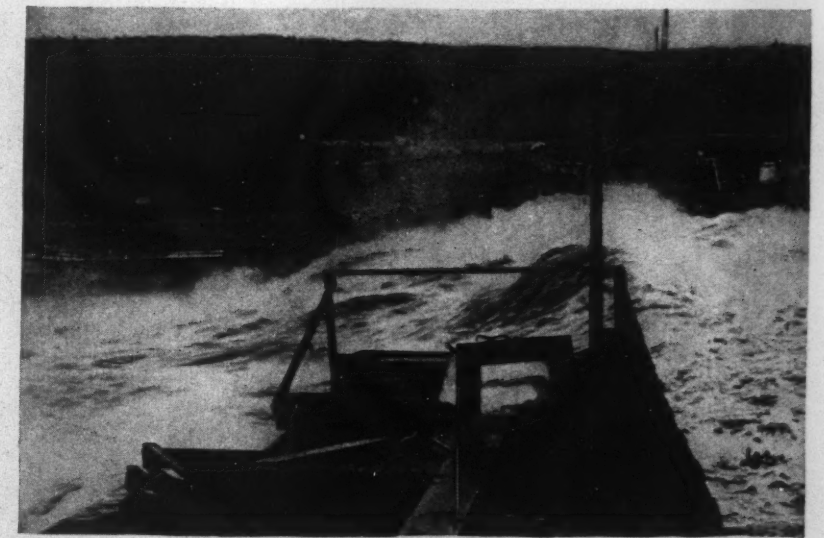
The bill does not appropriate any money for construction; it merely authorizes the U. S. Engineers to carry out the approved projects when and if money is appropriated in future War Department civil functions appropriations.

• • •

Injunction Is Sought On High Point Project

Trial of a suit to prevent the city of High Point, N. C., from building a $6,500,000 hydro-electric project on the Yadkin River began in Guilford County Superior Court last week. The city has obtained a license for the project from the Federal Power Commission and plans to finance the project by the issuance of revenue bonds.

The Duke Power Co. and about 45 local citizens and corporations, who are bringing the suit, contend that the project will have no effect on the navigability of the Yadkin River or of the Pee Dee River, to which the Yadkin is tributary. They hold that the power commission therefore was without authority to issue a license and that the city cannot build the project unless it obtains a certificate of convenience from state authorities. They contend also that the plant will cost more than the $6,492,000 which is to be obtained from a PWA grant and the sale of revenue bonds and that the excess will be a direct obligation on the city, in violation of the constitutional debt limit.



ST. MAURICE FLOOD WRECKS COFFERDAM

A 15-FT. RISE in the St. Maurice River early this month tore away the top of this cofferdam for a length of about 200 ft., doing $50,000 damage. The cofferdam was being used in the construction of a $16,000,000 hydro-electric project near La Tuque, Que., which is being built by the Quebec government and the St. Maurice Power Development.

New Plan Submitted For Battery Bridge

New York shifts location and lengthens one span to meet War Department objections

Gen. Julian L. Schley, chief of engineers of the U. S. War Department last week refused his approval to New York City's plan for a bridge connecting the Battery in Manhattan with Hamilton Ave. in Brooklyn across the mouth of the East River on the score that the tandem suspension bridge proposed would require construction of two main piers and a joint anchorage in the East River near Governors Island which would constitute an unreasonable obstruction to free navigation. Since Gen. Schley's report said that he was prepared to consider modifications of the plan, the Triborough Bridge Authority, on Wednesday of this week, submitted a revised layout to Col. C. L. Hall, district engineer at New York.

The new plan retains the two suspension bridges end to end but shifts the central anchorage in against the Governors Island shore. This places the two bridges at an angle to one another, instead of on a tangent, and requires a change from a joint anchorage to separate anchorages set about 260 ft. apart; such separation will permit a 1000-ft. radius curve in the roadway. The Manhattan span of the new design is 2400 instead of 1600 ft. while the Brooklyn span remains at 1600 ft. The total length of bridges and approaches is given as 11,000 ft.

The effect of the changes is to remove the anchorage and piers from the navigation areas and to give increased channel width on the Manhattan side. The 150 ft. vertical shipping clearance is retained.

No changes are said to be required in the Manhattan or Brooklyn approaches. The new plan raises the estimated cost of the bridge from $41,200,000 to $44,000,000.

• • •

L. C. Frank Promoted In Public Health Service

Leslie C. Frank, senior sanitary engineer of the U. S. Public Health Service, on May 15 became chief of the engineering section of the service, succeeding R. E. Tarbett. Tarbett will continue his activities in the same division of the health service.

Frank has been connected with the service since 1914 and earlier worked for the Baltimore Sewerage Commission. He is a graduate of Cornell University and has worked in Germany with Karl Imhoff.

Works Planning Discussed

Speakers at planning conference in Boston forecast no permanent shifting of works from local to federal authority

Current public-works problems were discussed before the National Conference on Planning held at Boston May 15–17, with special reference to the division of construction between federal, state and local governments. Two speakers forecast no essential change from the present division of authority. A third speaker proposed a system of city finance designed to stabilize public-works employment and prevent depressions.

Declaring that the depression was intensified by decrease in local public-works construction, William Stanley Parker, Boston, chairman of the Construction League, proposed as a cure for depressions that a public-works reserve fund be established by every city as a mandatory requirement under state law. In good times the city would lay aside a certain part of its annual works appropriation, say 2 to 5 per cent, to build up a reserve for use in continuing its public improvements in bad times. This reserve would be drawn upon to maintain works construction at full rate without burdensome taxation whenever a prescribed economic index falls below a certain figure. A bill to carry the plan into effect is now before the Massachusetts legislature.

Future public works will be under the same administrative jurisdiction as now, said Frank W. Herring, executive director of the American Public Works Association. Federal grants to aid construction of local works may be found to be justified where the works are of national interest, but this interest must be substantial. During the past six years the federal government was concerned not in local works themselves but in the expenditure of money which they involved, a condition that cannot continue long. As the use of public works for relief is controlled by criteria wholly different from those based on the usefulness of the works, it may be expected that elimination of relief spending will improve the basis of works selection and programming.

Harold M. Lewis, New York, director of the Regional Plan Association, remarked in discussing Mr. Herring's paper that many cities have not known their needs well enough for proper works programming, and that the development of plans adapted to advance programming can be done effectively by city, regional and county planning bodies. T. T. McCrosky, New York, director of planning, City Planning Commission, suggested that federal funds might properly be granted in aid of local works if these conform to a long-time plan approved by federal authorities.

Federal works programming involves difficult problems of priority, selection and balance between the various fields of national development, according to F. E. Schmitt, New York, editor of *Engineering News-Record*. As carried out during the past seven years under the Employment Stabilization Act, the programming has failed to be effective in stabilization but has fostered advance planning by federal agencies and developed better choice of priorities and a sense of timing. Some of the present programming difficulties might be overcome, the speaker suggested, by a method like that used by contractors and by large industries, namely functional planning and programming on the basis of definite times of completion of the several plans. However, federal programs are affected by great increase in joint state-federal problems, and adequate methods for dealing with such problems need to be developed.

Balance of federal development expenditures was discussed by Thorndike Saville, dean of engineering, New York University, who pointed to the recent increase of flood-control appropriations beyond the recommendation of the Budget Bureau as an instance of unbalance.

Science Service

BOWIE RECEIVES BOWIE MEDAL

FIRST RECIPIENT of the newly established William Bowie medal for "advancement of cooperative research in fundamental geophysics" was Dr. William Bowie himself, former chief of the division of geodesy of the U. S. Coast and Geodetic Survey. The award was made at the recent meeting in Washington of the American Geophysical Union.

Bowie retired from the U. S. Coast and Geodetic Survey in 1936, having spent his entire professional life with the Survey.

• • •

Bridge, Building Designer Dies at Sixty-eight

Wilbur J. Watson, head of the Cleveland consulting firm of Wilbur Watson & Associates, died in Cleveland May 20 at the age of 68. Watson's best known project was perhaps the Goodyear Zeppelin dock at Akron, on which he was consultant for the Goodyear Co., but other projects of his design included the Lorain-Central Bridge, the Main Ave. Bridge now under construction in Cleveland, the Akron Viaduct, the Willoughby Viaduct, the northern Ohio food terminal, and the Lincoln Storage Co. building in Cleveland. One of his most recent jobs was the design of the Industrial Rayon Co. plant at Painsville, Ohio; this building, which incorporates the largest area of glass block walls yet used, was completed last fall at a cost of $11,500,000.

Watson graduated in 1898 from the Case School of Applied Science and worked for a number of years with the Osborn Engineering Co. of Cleveland, mostly on bridge work. He worked with the Van Sweringens on the development of rapid transit traction lines in Cleveland, and in 1917 he formed his own firm.

Watson was a past director of the American Society of Civil Engineers and a past president of the Cleveland Engineering Society. He was the author, in addition to numerous technical articles, of "Bridge Architecture," "A Decade of Bridges, 1926-1936," and "Bridges in History and Legend."

Other sessions of the planning conference dealt with urban and rural planning, national income distribution, community reclamation, housing, transportation, and industrial migration. Participating organizations were the American Institute of Planners, American Planning & Civic Association, American Society of Planning Officials and National Economic & Social Planning Association. The conference was under direction of Elisabeth M. Herlihy, chairman of the Massachusetts Planning Board.

OBITUARY

EUGENE H. VIERLING, area engineer for the U. S. Engineer Office at St. Louis was killed May 11 in an automobile accident. A member of the U. S. Engineer Department since 1921, Vierling was in charge of river and harbor construction between St. Louis and Cairo.

HARRY G. SHANNON, for 33 years an engineer in the construction division of the Chicago bureau of engineering, died there May 17.

HENRY E. SMITH, Baltimore engineer and contractor, died in Baltimore May 11 at the age of 54. Smith, an engineering graduate of Cornell in 1906, practiced in New York for some years and then entered the contracting business in Baltimore. He retired about two years ago.

JOHN WISE, president and treasurer of Wise & Upson, Hartford, Conn., construction company, and former building commissioner of Hartford, died there May 11 at the age of 69.

DANTE H. TASSINARI, a civil engineer on the staff of the Boston Metropolitan District Commission, died in Boston May 13. A graduate in 1927 of Northeastern University, Tassinari was connected with the construction of the Wellington and General Lawrence bridges over the Mystic River.

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New York Passes Housing Law

(*Continued from p.* 43)

for construction of low cost housing projects. In addition, the state will make annual subsidies to reduce the carrying charges on the loans. Immediately available is $250,000 a year of subsidies, and the maximum total annual subsidy is limited to $1,000,000.

It is specified that not more than two-thirds of the funds made available may go to New York City.

In order to permit the communities to take advantage of these loan provisions, the measure permits them to borrow, either from the state or from private sources, up to 2 per cent of their assessed valuation outside of their constitutional debt limit. This is subject to the restriction that they levy any of six specified taxes to meet the carrying charges on the loans.

The new housing bill does not take full advantage of the provisions of last November's constitutional amendment. The amendment authorized loans up to $300,000,000 and subsidies up to $5,000,000 per year.

LAST CONSTRUCTION STAGE AT CHICKAMAUGA DAM

CONSTRUCTION operations at TVA's Chickamauga Dam across the Tennessee River above Chattanooga now center in the power house where the building framing and floors are being placed and the generating equipment installed. In the foreground is a base ring for one of the three 264-in. dia. turbines in the initial 108,000-hp. development. The power house is 400x118 ft. in plan and 97 ft. high above the generator floor. Turbines are built by Baldwin-Southwark and the generators by Allis-Chalmers. Lee Warren is TVA project manager on the work.

Building Settlement May Boost Subway Cost

Settlement of buildings on State St. in Chicago at points where tunneling is in progress for the new subway indicates that the cost of the subway may be materially increased because of the necessity of protecting and repairing the buildings along the route. Screw jacks are already in use under some of the buildings affected in order to take up settlement of the foundations.

Whether the responsibility for payment for building protection work rests with the city or the building owners is a question now under discussion.

The subway along State St. is 40 ft. below street level, mainly in clay. The work so far has been done by hand excavation under air pressure, with metal lining being placed close behind the excavation. It is now intended to adopt the shield system, using 25-ft. diameter shields 15 ft. long.

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

REFUSAL of PWA to release projects to WPA is interfering with the effectiveness of the latter organization, some members of Congress claim. In order to take care of all types of unemployed workmen, WPA does a certain amount of building construction. Applications covering the best projects of that character were made originally to the PWA, but since the time that PWA allocations stopped WPA has been in a position to take over some of the small projects. PWA, however, does not want to release them. Members of Congress from districts where projects thus are being held up claim that PWA is refusing to release these projects so as to gain support for a new appropriation.

TESTIMONY in the WPA investigation shows PWA has provided little employment in the poorer counties. Those counties have not been able to put up their fifty-five per cent, and their chief reliance has been WPA.

REORGANIZATION Plans I and II, which, among other things, consolidate construction and relief bodies into a Federal Works Agency, will go into effect July 1, when the fiscal year begins, under the terms of a joint resolution passed by the Senate. Otherwise, Plan I would have gone into effect June 25 and Plan II July 7.

BOULDER DAM power sales during the first quarter of 1939 totalled about $900,000 as compared with sales for the same period last year of $480,000, Commissioner of Reclamation Page announced May 18.

THE RIO GRANDE compact has been approved by Congress. The compact, which allocates the water of the Rio Grande among Colorado, New Mexico, and Texas, was agreed to in March, 1938.

RECLAMATION water users who are unable, in the judgment of the Secretary of the Interior, to make the 1938 construction cost repayments without undue hardship may receive an extension of time, under the terms of a bill which has passed both houses of Congress.

CONSTRUCTION of a toll bridge across the Mississippi River at Chester, Ill., by the city of Chester is authorized in a bill which has passed both houses.

CONTRACTS AND CAPITAL

ENGINEERING construction awards for the week, $71,322,000, are 117 per cent above the volume for the corresponding week last year and 27 per cent higher than last week. This is the tenth time in the past eleven weeks that current awards have topped their respective 1938 values.

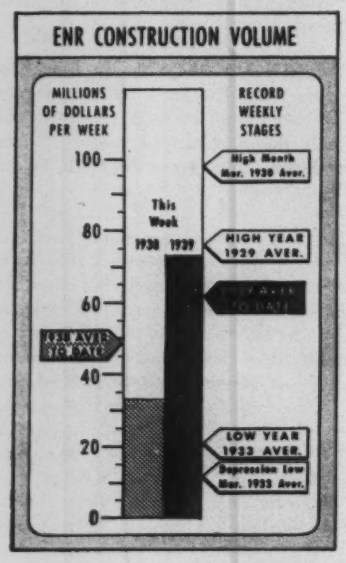
Construction volume for 1939 to date totals $1,294,829,000, a 25.5 per cent increase over the $1,031,865,000 reported for the initial 21-week period last year.

Private awards for the week are 154 per cent higher than a year ago, and 31 per cent above a week ago. Public construction is 104 and 26 per cent higher, respectively, than last year and last week.

In the classified construction groups, gains over a year ago are reported in sewerage, industrial buildings, commercial building and large-scale housing, public buildings, streets and roads, and unclassified construction. Gains over last week are in sewerage, bridges, commercial building and large-scale housing, public buildings, and streets and roads.

New capital for construction purposes for the week, $20,723,000, is 255 per cent above the total for the 1938 week. The week's financing is made up of $10,654,000 in REA loans, $6,177,000 in state and municipal bonds, and $3,892,000 in corporate security issues.

New construction financing for the 21 weeks of 1939 totals $834,554,000, a 48 per cent increase over the volume for the corresponding 1938 period. Of this total $396,380,000 is private investment, ten per cent over last year.



CONTRACTS

(Thousands of dollars)

	Week Ending May 26 1938	May 18 1939	May 25 1939
Federal	$1,697	$3,412	$5,556
State & Municipal	22,618	36,090	44,147
Total public	$24,315	$39,502	$49,703
Total private	8,535	16,511	21,619
TOTALS	$32,850	$56,013	$71,322
Cumulative 1939 (21 weeks)			$1,294,829
1938 (21 weeks)			$1,031,865

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1938 21 Wk.	1939 21 Wk.
NON-FEDERAL	$478,354	$523,127
Corporate securities	119,600	118,062
State & Mun. bonds	239,555	278,318
R.E.A. loans	250	37,801
R.F.C. loans	63,420	234
P.W.A. allotments	2,036	.....
U.S.H.A. loans	53,493	88,712
FEDERAL	$86,532	$311,427
TOTAL CAPITAL	$564,886	$834,554

FHA MORTGAGES

	Week Ending May 21 1938	May 13 1939	May 20 1939
Selected for appraisal	$22,991	$25,723	$25,814*
Cumulative 1939 (20 weeks)			$464,878*
1938 (21 weeks)			$336,002

*Subject to revision.

ENR INDEX NUMBERS

Index Base		1913	1926
Construction Cost	May	234.69	112.82
Building Cost	May	196.60	106.28
Volume	Apr.	221	97

Small Building Fails In New Jersey

A small building of hollow cement block construction, which was being built for the Army as a WPA project, collapsed May 22, killing one man.

Intended to form part of the plant of a citizens military training camp at Fort Hancock, N. J., the single story 45x20 ft. building had walls built of a single course of hollow blocks about 5 x 10 in. Walls had been completed and the roof trusses were in place.

The cause of the failure is not definitely known, but it is believed that one wall bulged at the top, permitting the roof to drop inside.

• • •

Correction

In an article entitled "Special Building Cost Indexes" published in the April 27 issue, page 85, reference was made to the indexes of Consolidated Engineering Company and Cummins Construction Corporation, both of Baltimore, which reference was somewhat confusing. These two companies are entirely separate and distinct entities, each of which is presently engaged in the construction industry, and each of which now publishes its own index.

The published figures for the years up to and including 1937 were furnished by Consolidated Engineering Company, and for the year 1938 by the Cummins Construction Corporation.

For the information of our readers, the compilation of indexes given on page 85 of the April 27th issue is reproduced in corrected form to include the figures furnished by each of the above-named companies.

Building Cost Indexes

Year	AGC	Boeckh New York*	Consol. Engr.	Cummins Constr.	Aberthaw	Fruin-Colnon	Fuller	Turner	Tuttle
1913	100	100	100	.....	.....	100	100	100	.....
1914	99	102	97.7	.....	100	100	101.5	100	100
1915	100	99	97.7	.....	100	102	129.5	103	100
1916	114	116	108.1	.....	107	108	143	120	108
1917	152	135	128.1	.....	126	128	156	147	139
1918	175	155	143.1	.....	147	173	160	166	149
1919	198	171	170.8	.....	172	174	168	196	172
1920	247	230	247.1	.....	234	227	209	252	237
1921	200	193	189.0	.....	170	197	188	183	179
1922	184	186.5	187.1	.....	179	188	175	175	170
1923	201	215	226.7	.....	202	217	190	196	202
1924	202	215	213.8	.....	198	223	194	194	202
1925	199	211	198.5	.....	195	222	193	195	200
1926	197	230	191.6	.....	196	218	202	195	204
1927	200	223	186.6	.....	193	214	197	190	198
1928	199	238	190.3	.....	191	213	196	190	195
1929	203	242	194.8	.....	189	211	201	185	196
1930	200	238	184.7	.....	188	207	199	165	178
1931	196	230	170.9	.....	179	196	180	145	162
1932	171	208	150.8	.....	169	178	157	136	155
1933	163	197	160.9	.....	168	181	155	140	153.5
1934	178	209	176.6	.....	176	191	171	160	173
1935	176	200	173.0	.....	176.5	185	167	162	173
1936	179	205	191.7	.....	195	187.5	168	169	180
1937	188	226	202.8	.....	199.4	210	186.5	192	198.5
1938	189	243	.....	193.8	191.1	207	192.1	188	.....

* Brick and concrete building, New York, series converted to 1913 = 100

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Mass Transportation: Who Should Pay for It?

Sir: The interesting editorial "City Transit Difficulties" (*ENR*, Oct. 13, 1938, p. 455), which concluded with the warning that "Mass rapid transit in cities remains a major problem of the urban community," has, much to my surprise, so far failed to evoke any response. There is urgent need for education, thought, discussion and action on city transit difficulties and the following is submitted in order to bring this major urban community problem before the engineering profession for consideration in the hope that this will in turn induce administrative officials and the public to face this situation realistically.

Granted that elevated railways are outmoded except at such locations and under such conditions as will minimize their objectionable features. Granted that at rates of fare warranted by the transportation service rendered, a subway is a luxury which must be subsidized. Granted that buses and private automobiles in urban transportation service, superimposed on essential commercial vehicles, congest and slow down surface traffic and make the life of the pedestrian a hazardous one. Granted that a mass transportation device that meets minimum present-day requirements of acceptability at a sufficiently low cost to be able to pay its way is not yet in existence.

For good or ill, we have the city, depending for its life on many services of which mass transportation is one. Police and fire protection, paved street and their maintenance are furnished at community expense. Sewerage systems and refuse disposal are generally accepted as being community functions. Water is, as a rule, paid for on the basis of the amount used, although it is sometimes directly or indirectly subsidized. Electricity, gas and telephone service are paid for on a use basis because any other method would encourage extravagance with resulting waste. In what group does city mass transportation belong?

Unless the mass transportation system serves the community adequately and efficiently, the city will cease to grow, forcing business, commerce, industry and the population to migrate to places where they can live and function to better advantage. Streets at one time adequate for all city traffic were always furnished, paved and maintained at community expense, and paid for in accordance with local laws. When traffic congestion makes it necessary to do so, streets are widened, new streets are cut through developed sections, elevated highways are built, speedways are constructed, heavier and costlier pavements are laid, all for the benefit of surface traffic. The city should and does provide these facilities at the taxpayers' expense and no one has yet claimed that the cost of city streets (as distinguished from intercommunity highways) is even remotely paid for by automobile license fees or gasoline taxes.

In large cities, even if streets were not congested with traffic, distances are such that the business district is no longer accessible from the residential areas in reasonable travel time, and these must be brought nearer to the community center by means of rapid transit. In cities where distance in miles is not the controlling transportation factor, surface traffic in the business districts and in surrounding built-up areas also exceeds the traffic capacity of the roadways. The resulting congestion impedes the movement of the mass transportation vehicle, whether it be street car or bus, to an extent that the journey between home and work requires so much time that it involves a serious economic loss to the community, because both the time and the cost of transportation for all surface traffic, are invisible items on every payroll. City streets were at one time adequate for all surface traffic, including the mass transportation vehicles, yet today those who do not own automobiles are, or shortly will be, compelled to travel underground in order to make more room for other surface traffic.

Since the city provides usable rights-of-way for all surface traffic, is it not reasonable that it also provide a right-of-way for mass transportation?

Elevated railways can furnish as speedy service as subways and being in the open air, many riders may prefer them to subways as a transportation medium. The construction of elevated railways is, however, taboo from a civic standpoint. Underground transportation appears as an alternative, so let us examine the possibility of financing a subway on a basis that would make it self-supporting at a rate of fare that is warranted by the transportation service rendered.

A subway is not merely a transportation medium because it also produces, in effect, a street widening by removing mass transportation from the street surface. This street widening is accomplished without the acquisition or destruction of abutting property. A subway avoids the necessity for the construction of elevated railways or elevated highways, which although less expensive than a subway have certain drawbacks from a civic standpoint and from the standpoint of abutting property.

If it is agreed that:

(a) The city is morally, if not legally, obligated to provide usable rights-of-way for all urban traffic;

(b) Elevated railways are barred in the community center;

(c) Subways are in effect a street widening of benefit to abutting and surrounding property;

(d) Rapid transit increases land value by bringing residential areas nearer to the community center:

(e) Rapid transit stabilizes real property values in the business district by counteracting decentralizing influence;

then a subway is more than a transportation medium and it should be financed accordingly.

Considering a subway to be a multi-purpose improvement and taking the foregoing factors into consideration, the cost of a mass transportation subway can be allocated to each function in proportion to benefit. If such an allocation of costs shows the transportation function to be self-supporting at a reasonable rate of fare, then the construction of a subway for mass transportation is on a sound financial basis and is economically justified.

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Editorial Offices at 330 West 42nd Street, New York

MAY 25, 1939

FLOOD-CONTROL WEEK has been announced, latest addition to the compendium of foolishness that includes National Iceberg Lettuce Week and the like. For those who take such celebrations seriously we have a suggestion: that they devote their spare time during Flood-Control Week to thinking of sound principles of handling flood control, and considering whether the recent laws that purport to make all flood control Uncle Sam's exclusive business are in the interests of progress. They may take note in fact that little flood control has gone forward under these laws, but that Congress within the past few weeks has taken flood control to its bosom with the same generous warmth traditionally accorded to river and harbor appropriations and, not satisfied with the Budget Bureau's recommendation of a 110-million-dollar appropriation, has increased the amount by more than one-half. In such an atmosphere it will be easy to lose sight of the principle that expenditures ought not to exceed the benefits they produce and that costs should be distributed in proportion to benefits received.

Idle Money and Construction

INDUSTRIAL LEADERS last week told the Temporary National Economic Committee that the way to get idle money into industrial expansion is to remove the factors that are widely recognized as working against business confidence, such as the undistributed-profits tax and the capital-gains tax. The committee is making a study of how to put idle money to work. Prof. Alvin H. Hansen, economist of Harvard, joined the industrialists in urging that idle funds be used for industrial expansion but carried the thought farther and pointed to the need for using a considerable part of them on public construction. A large and regular amount of new construction, he holds, is essential if the country is to escape periodic times of large unemployment. Consequently he would not wait in times like these for idle capital to venture into new and often speculative enterprises. He would force it into new construction through a tax on savings (rather than on consumption), which tax money could be used not only for public work but also to provide needed capital for large private or semi-private enterprises. Though Prof. Hansen's proposal is radical and self-destructive, it can serve the useful purpose of keeping public attention centered on the fact that there must be both regularity and a high volume of new construction if the nation is to prosper.

Expensive Haste

THE OLD SAYING "Haste makes waste" is often true in construction, especially in the handling of explosives. Elsewhere in this issue John Jeffries, explosives expert, points out the fallacy of improper loading and hooking up and the neglect of a careful check-up that requires only a few moments in the rush to get the shot fired. Such neglect and lack of precaution are often expensive and always dangerous, for they may result in dreaded misfires. The article, which also discusses common mistakes in blasting methods, deserves the attention of everyone who handles explosives. Good blasting means maximum results from the labor and explosives involved; anything short of the best blasting procedure is too expensive and dangerous to tolerate.

State Subsidized Housing

PASSAGE LAST WEEK of a public housing act by the New York state legislature marks the first instance of state aid to municipal housing authorities. This is significant, for previously all funds for subsidized housing have come from the federal government, excepting only one small project in New York City for which the city itself is providing the financing. But the New York legislation is most significant as being the first in the public housing field that may be said to stem directly from the will of the people, since it implements a constitutional amendment approved by the voters of the state last November. In this respect it differs from the federal legislation, which represented only Congressional decision. If it may be assumed that New York voters knew that they were binding the state treasury to pay upwards of half the economic rent for certain low-income families but that they were not assuring that the present slum dwellers would find accommodations in the new housing, then it can be said that New York has approved the principle of subsidized public-owned housing. This questioning note is sounded here

once again because it is imperative to keep clearly in mind, first, that public housing will eventually involve huge outlays of funds and, second, that it benefits a low-income class considerably above the actual slum dweller.

Grass Filters for Sewage

AUSTRALIA AND OHIO are far apart in distance but close together in the practice of sewage treatment with grass filters. In this issue appear accounts of how additional purification was obtained by passing settled effluent over a sodded area before its discharge into a stream. Almost any kind of grass appears to be suitable, although Italian rye and buttonweed are favored in Melbourne, Australia, where 967 acres of filter area are in use. New plants now under construction in Wellington and Geneva, Ohio, are being equipped with grass filters following successful operation of an installation at Medina. While the grass filter is not a "purification" device in the true sense of the word and in no way is a substitute for secondary treatment where oxidation is sought, it has possibilities as a simple and cheap adjunct to sewage treatment in small plants.

Bonding Concrete under Load

ADDING both thickness and height to a concrete dam and at the same time doing it in such a way that the enlarged mass will act as a unit after the water load comes on the added portion was the critical problem faced by the engineers who designed the addition to O'Shaughnessy Dam. The original design provided for the raising that has just been completed, and the downstream face of the structure was stepped to support the new concrete. But study soon showed that something more than steps and careful bonding was necessary. Provision had to be made for construction of the new concrete and its adjustment to load when the reservoir filled. The ingenious method adopted is described in this issue. By careful control over the concrete mixtures to minimize shrinkage, by separating the new from the old concrete initially and by cooling it artificially while so separated, the present designers believe that the whole mass was made to act as a unit after the separating slots had been filled with concrete and the joints had been grouted. Thus methods of concrete control that have been developed since the dam was first built, improved methods of grouting and artificial cooling of concrete, all have helped to make the original designers' plan a reality.

A Master Highway Plan

THE NEED for express highways in the future development of road transport is rarely disputed. The debatable question is how to produce these transport accommodations in a sensible and economic way. Commonly the methods proposed have been imaginative and extravagant; the best that can be said of them is that they indicate awareness of a new public-roads need, and this understanding is important to sound express-road study and planning. The investigation ordered a year ago by Congress of six cross-country superhighways to be paid for by tolls and right-of-way concessions is an example; it has performed the important task of bringing out an intelligent program of public-roads development.

Fortunately the nation had in the Bureau of Public Roads an agency capable of assembling facts and applying them to the fantastic superhighway schemes placed before Congress. The bureau's report, outlined in these pages two weeks ago, discards the scheme that Congress laid before it, but that is by no means its principal accomplishment. The most important part of the report is its master plan for coordinated highway improvement.

In this plan the express road takes higher rank even than in the most elaborate of transcountry grids, but it is a coordinate development of modernized general-service main roads and secondary feeder roads with particular consideration of city entrances and belt-line roads. This by all traffic logic is the plan of road improvement that will best meet transport needs.

More boldly than ever before the report declares that the express road must enter the city to its center and leave the city from the center. The across-city routes must be of limited access; they are freeways for traffic of outside origin to the city and of city origin to the outside. Similarly the belt road is considered a freeway for traffic interchange. The traffic logic is unassailable, and cities must bow to it even though it means unprecedented cost and right-of-way and construction difficulties, or they will be penalized by blighted areas far greater than those of the present day.

Neglecting details, the greatest usefulness of the report lies in the fact that it squarely presents the future highway transport problem in its full magnitude. Money and engineering vision beyond all precedent are demanded by growing road-transport needs, and the public has to be brought to know this. This is the task of the highway industries; it is one in which all have a part and can cooperate.

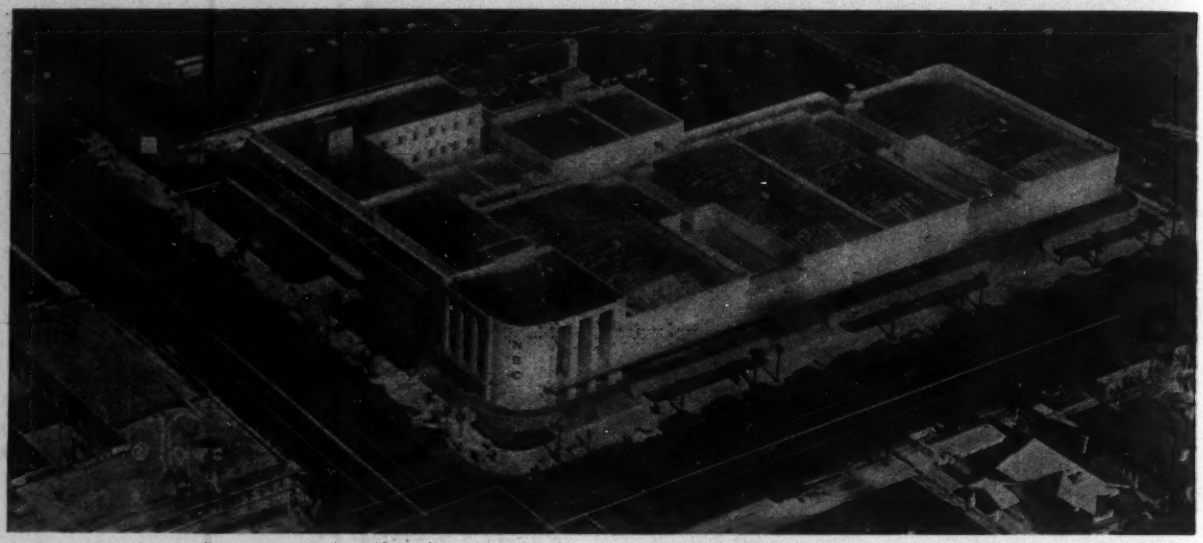

FIG. 1. EIGHT INDIVIDUAL BUILDINGS MAKE UP N.B.C.'S RADIO CITY IN HOLLYWOOD.

Radio City in Hollywood

Contents in Brief—New building for National Broadcasting Co. is made up of a group of separate one-story studios and a three-story office building. Welded frame, colored concrete walls, glass block panels and timber truss roof are structural elements. Primary requirements were efficient acoustics, earthquake resistance and striking architecture.

AT SUNSET AND VINE in Hollywood stands the National Broadcasting Co.'s latest monument to progress in radio, a new studio and office lay-out that contains a number of notable features. Located on a 4½-acre plot, this western Radio City gives the appearance of being a single building, whereas in reality it is made up of a number of separate units suggestive of Hollywood movie studio practice but dictated by structural and acoustical requirements. Four of the units are large 340-seat theatre studios each with its own entrance foyer, sound stage and artists' dressing rooms; each has its own foundation and is completely isolated from all other parts of the layout. Four smaller units complete the studio facilities, and in addition there is a three-story L-shaped administration building, one leg of which extends 250 ft. along Vine St. The lobby to this building, located at one corner, is 50 x 50 ft. in plan and has a 40-ft. ceiling.

By day the building presents an unusual appearance by virtue of glass block wall panels between the studios and shaded concrete walls of light blue-green above a dark green terrace wall, contrasted with red concrete paving on the promenades and red terra cotta on the steps. At night, with the glass block panels lighted from behind and three fluorescent tubes extending the full length of the aluminum covered cantilevered canopy above the promenades, the building is even more striking.

Structurally, the building consists of welded steel frame (in office building only), concrete walls and wood roofs; floors are concrete except for upper stories of office building, which are wood. The principal exceptions to this design are a corridor behind the large studios, which can serve as an emergency exit, and that part of the building that houses the broadcasting equipment, both of which are of all-concrete construction. Timber bowstring trusses are used over the large studios and support timber rafters which are covered by 1-in. timber sheathing, 1 in. insulation board, a composition roofing and a spray coating of aluminum paint, the latter used to reflect as much of the sun's heat as possible. Ceilings over all studios are insulated for both sound and heat.

Walls of the separate building units are separated by air spaces, are carried down to separate footings, and have no solid contacts at any point. This separation of footings where the walls are so close together necessitated considerable engineering detail to prevent the footings from touching. This was accomplished by picking up wall panels on beams and carrying them to spread footings, straddled in turn by other beams to other spread footings. A basement is utilized under about half of the area, and all footings extending to the basement are tied together in accordance with Los Angeles earthquake requirements for buildings of two stories or more in height.

Concrete floors that frame into the concrete walls of the studios are carried on integral concrete brackets, floor and bracket being separated, for acoustical purposes, by a bed of cork so shaped as to give both vertical and lateral support. Other sound control details include the separation of fin-

ished floors and walls from the structural floors and walls by spring isolators and the use of "sound lock" entrances to all studios. Ceilings are plastered on perforated gypsum board lath and in the studios are insulated with 3 in. of rockwool, while studio walls consist of perforated wood fiber board backed by 2 in. of rockwool.

Air-conditioning equipment is located in the basement. The studios are completely air-conditioned, with separate systems for each of the four large studios to prevent development of air-borne sounds in ducts between the stages. Eighty-five thousand gallons of water, maintained at 39 deg. cool the air, which moves through quilted ducts.

The concrete walls of the studios are 8 in. thick, reinforced horizontally with ½-in. round bars, 18-in. centers, and vertically with ⅜-in. round bars, 18-in. centers. This reinforcement is double, being placed 1¼ in. from each face of the wall. The concrete mix was 1:2½:3½, with a slump of from 4 in. to 5½ in. From 5½ to 5¾ sacks of cement were used per yard of concrete.

Concrete was placed by canvas elephant trunks, and pour heights ranged from 8 ft. to 12 ft., being governed by interference of reinforcing steel. All walls were kept wet for a period of at least one week after pouring.

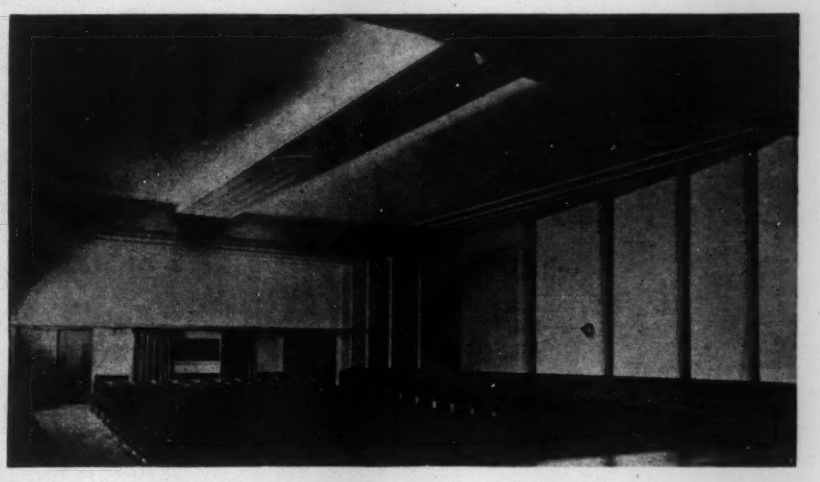

Fig. 3. In the large studios curves and set-backs are provided in the walls to break up the surfaces into small units as an aid in acoustical control.

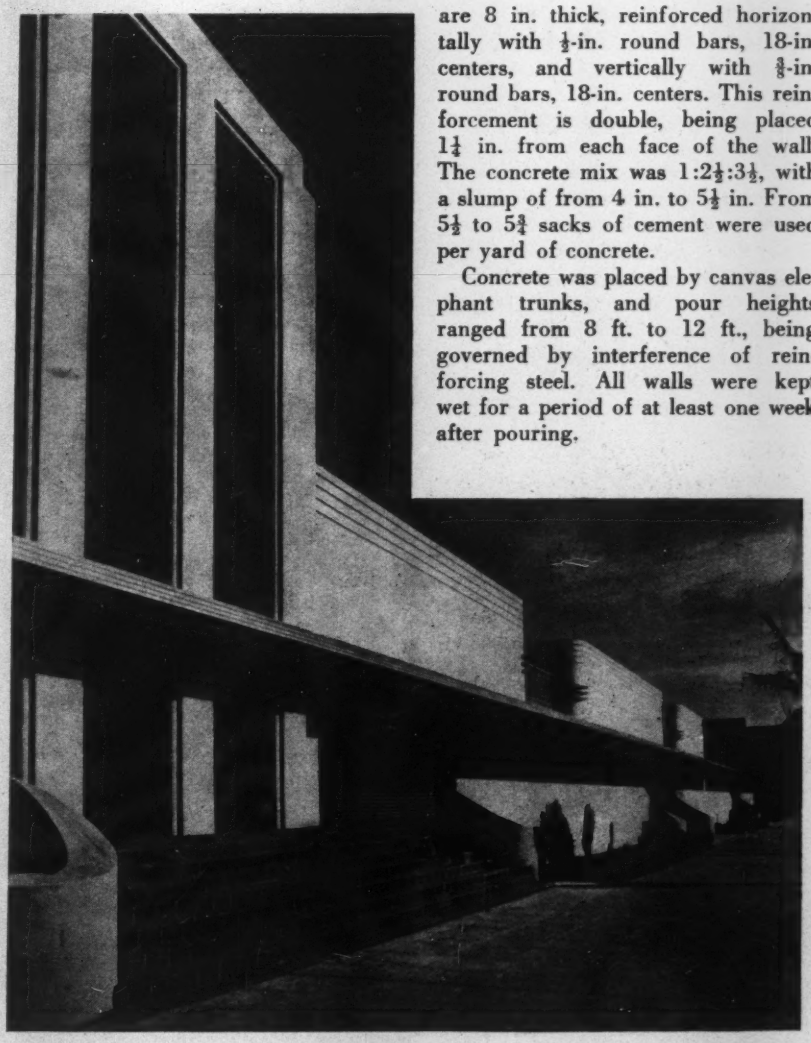

Fig. 2. Concrete exterior is finished in blue-green. Steps and promenades are in red terra cotta. Glass block panels close ends of corridors between studios and admit light to lofty lobby at left.

Exterior wall forms were of five-ply wood panel board, 3x8 ft. in size and placed horizontally. Curved corners were cast in wood forms made up at the job of ¾-in. strips nailed to curved frames and lined with plywood rather loosely tacked in place so that when the concrete was poured it would take the shape of the backing.

While the concrete was being placed the forms were vibrated with a small electric jackhammer, care being taken not to over-vibrate since this tended to cause sand streaks in the concrete surface.

The long frontage of the administration building—nearly 300 ft.—required the introduction of numerous joints in the walls. It was required that these joints should not be placed over 20 ft. apart and wherever possible should be placed in the center of bays, or at points of zero shear if they cut a member of structural importance.

These wall joints were made by installing small vertical metal strips in the concrete forms, so placed that they would project into the wall ½ to ¾ in. on both sides of an exposed joint about ¼ in. wide. Sufficient movement was expected at these cracks to warrant the use of a plaster bead to take up the movement in the plaster. On the outside of the wall the joints are filled about half full of mastic to prevent leakage.

The Austin Co., Cleveland, acted as both engineers and builders on the National Broadcasting Co. building. O. B. Hansen is chief engineer of N.B.C.

FIG. I. WELDED AND CONCRETE-FILLED FLOOR PANELS OF STEEL SHEETPILING REPLACE THE OLD BRIDGE DECK.

Suspension Bridge Rebuilt Under Traffic

Contents in Brief—A 40-year-old suspension bridge over the Ohio at East Liverpool was completely rebuilt under traffic. Features included all-welded construction of the new steelwork, a light-weight floor of sheetpile panels filled with concrete, sheetpile guardrails, welded steel sidewalk and welded sheet metal toll house. Cables, anchorages and steel towers were also strengthened.

AN UNUSUALLY clever job was the complete reconstruction last year of the superstructure of the 40-year-old suspension bridge over the Ohio River at East Liverpool, Ohio, without serious interference with traffic. New stiffening trusses and top laterals, a new and wider floor of arch web steel sheetpiling, new floor beams, guardrails and sheetpiling, additional tower and anchorage steel and additional strands on the cables were all placed while cars and trucks rolled between Ohio and West Virginia, stopped only occasionally "about as long as a red traffic light wait" as one engineer expressed it. C. M. Neeld, of Pittsburgh, who acted as both engineer and contractor on the job, used welding to good advantage throughout. The resulting reduced dead load, combined with greater strength of structure, has increased the live-load capacity fourfold. All-welded construction has produced a remarkably clean-looking, economical structure that will serve traffic requirements for years to come.

The old bridge was owned by a traction company, but had long been a toll crossing for highway traffic only. As it carried the Lincoln Highway across the Ohio, it became one of the busiest and most important bridges on the river. Closing of the bridge during reconstruction would have greatly inconvenienced the traveling public, and besides would have resulted in a considerable loss in toll revenue to the owners. Tolls collected during the rebuilding operations more than paid for the cost of the work.

Fig. 2. Half-width panels are carried from fabricating yard to position in the bridge by a "strongback" mounted on steering trucks. In this view the old decking has not yet been entirely removed.

The old structure consisted of a center span of 705 ft., two suspended side spans of 360 ft. and 420 ft., and approach fills, giving a total length of structure of 1,485 ft., and a length from end to end of 1,914 ft. Two 7-in. cables supported on steel towers, which rest on masonry piers, tied in to stone masonry anchorages, supported a wood deck floor 18 ft. 2 in. wide, and one sidewalk. The cables are cradled, that is, they are 30 ft. apart at the towers, and 22 ft. at the anchorages and at the low point of the center span; cable sag is 59 ft. The stiffening system was light steel riveted trusses with top and bottom lateral bracing.

Built 40 years ago, the structure had become too narrow and light to meet modern traffic requirements. Mr. Neeld was asked to do something about it, and did an amazing job with electric welding machines and steel-

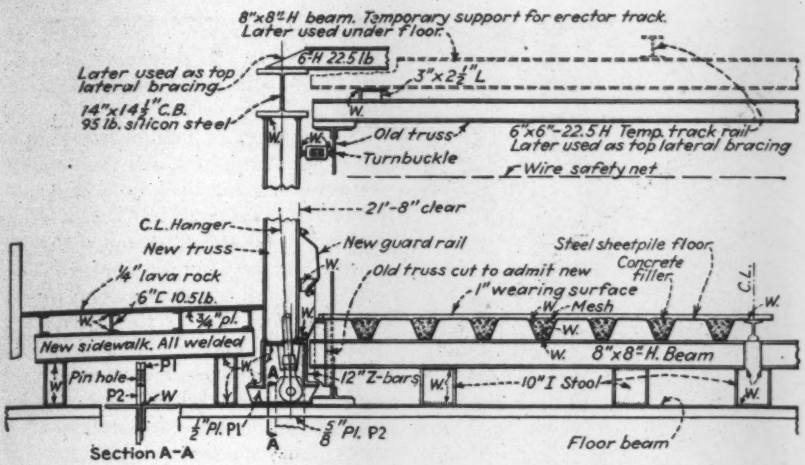

Fig. 3. New welded steel trusses were built outside of the old ones with the latter still in place, then the steel floor panels were placed on half the roadway width at a time.

work fabricated entirely on the job. He had replaced the floor beams in 1934, so had that much of a start on the reconstruction, but because the new floor was only 7½ in. thick as compared with 25 in. for the old deck, additional beams and stools had to be placed on the floor beams.

New type bridge floor

An outstanding feature of the job was the use of a new type of bridge floor, developed and patented by Mr. Neeld. It is simply arch-web steel sheetpiling, 52½ ft. long, laid with interlocks down and abutting, but not locked, and welded along the contact interlock edges into panels, 52½ ft. long and full width of the floor. The depressions, or valleys, over the interlocks, are filled with concrete, reinforced with expanded mesh, flush with the top of adjacent arches, providing a smooth, level floor surface. After the flooring was in place in the bridge, it was given a 1-in. bituminous wearing coat. The complete floor weighs 48 lb. per sq.ft. with a minimum steel thickness of ⅜ in. As the floor was fabricated from stock material shipped from the mill, and with little field work required, it was comparatively low in cost.

The flooring was assembled, welded and filled with concrete in a yard just off the West Virginia end of the bridge, under a 60x60-ft. tent. Sheets were laid out on two platforms for welding, and were filled as fast as fabricated. As a panel was completed, another was laid out over it. The sheets were laid out on, and welded to, 8x8-in. beams, 15 ft. c. to c. that rest on the old floor beams.

The main transverse floorbeams had been placed by Mr. Neeld in 1934, and this was the only part of the steelwork not affected by the recent reconstruction. Erection of additional tower steel, placing of the supplementary cable strands and anchor bars, and building of a new all-welded sheet-metal toll house proceeded with reconstruction of the floor and truss system. All cable hangers were replaced.

The old stiffening truss system, a light riveted through truss, was replaced by an all-welded through truss built outside of the original structure. Hangers and cables cut through the new trusses at various points, varying with the cradling and sag of the cables (Fig. 4). This new steel, all in place before the old trusses were dismantled, was erected in a novel manner.

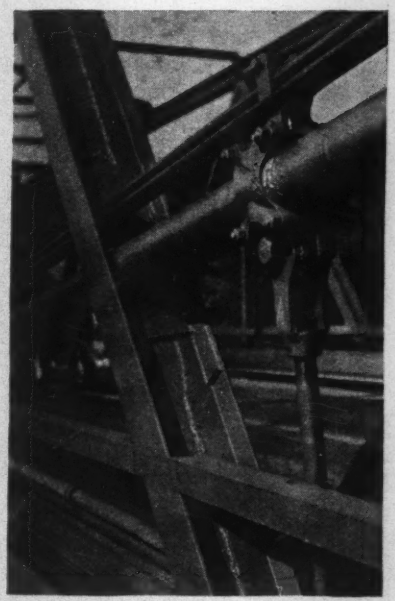

Fig. 4. Cables were strengthened by the addition of four strands of wire rope. The cables were outside the original trusses, but pass through the new truss members at various points.

Fig. 5. All-welded reconstruction made a modern bridge out of an old one. Note the sheetpile guardrail, behind which runs a telephone conduit. The gentleman is C. M. Neeld, who planned and carried out the reconstruction operations.

The first step in truss erection was to place the bottom chords, each consisting of two 12-in. Z-bars, top flanges facing, lapped and continuously welded to form a 3-sided box girder. These bars were notched around the hanger rods. It was necessary to cut away part of the flanges at the lower end of the old truss verticals and diagonals to make room for the new bottom chords.

A track to carry the erection cranes was built on top of the old truss. It consisted of transverse 8x8-in. beams resting on small angle clips welded to the tops of the old struts to clear the existing rivet heads, and two 6x6-in. H-beam longitudinal rails. The transverse beams were later used as assembly and raising beams directly under the steel floor, and the track beams became the permanent top laterals of the truss system.

Two motor trucks fitted with flanged wheels and light crane booms served as erecting cranes. Incidentally, the front wheels and steering apparatus of these same trucks were used in the gantry rig that handled the floor panels. These cranes set all the truss verticals, diagonals and top chords—the last being 12x14-in. and 14x14-in. 95-lb. H-beams of silicon steel. All truss connections were arc-welded to full strength.

The new trusses were lined up and held until top laterals were in place by threaded bolts welded to old and new steel, connected by a turnbuckle. Some such arrangement was necessary because of bad alignment of the old trusses. This feature and a cross-section of the old and new steelwork are shown in Fig. 3.

After being cut up by torches, all of the old steel was removed by truck cranes operating from the roadway. When the old trusses had been cleared away the next reconstruction step was replacement of the original wood deck flooring with the new steel sheetpile panels.

Floor construction

Because of easier handling and to permit keeping one lane open to traffic, the floor panels were split longitudinally by torch cutting prior to moving from the assembly yard to the bridge. This left the split web unsupported, so a railroad rail was welded longitudinally (head upward) between the bottom of the overhanging flange and the top of crossbeams. This was done only on the half-panels

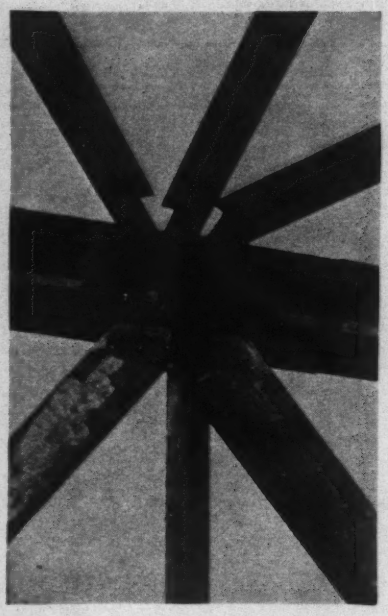

Fig. 6. Typical intersection of top chord, top laterals, and vertical and diagonal truss members shows the neat job done by welding.

that were placed in the first lane of traffic. Each half panel covered 551 sq.ft. of deck.

The half-width panels were moved from the assembly yard to position in the bridge by a 60-ft. welded pipe gantry (Fig. 1). This gantry is mounted on a steering truck at each end. With this rig the floor sections were lifted off the fabricating pile, moved out over the traffic lane to opposite the point of placement, then shifted laterally and dropped into a 52½-ft. long hole torn out of the original decking. Welded end splices on the panels were made at quarter points between floorbeams.

As the new floor system was much thinner than the old, to keep the two roadways at the same level during construction it was necessary to weld short sections of 10-in. beams as stools to the top of main floorbeams. The beams under the sheetpiling rested on and were welded to these stools as the panels were set.

Floor replacement was done in remarkably fast time; panels for the first half of the roadway, aggregating 1,450 ft. long, were set in 53 working hours without stopping traffic. About 3 in. additional width in the roadway was obtained by cutting loose the railroad rail stiffener tacked to the centerline edge of the first half-width panel, turning it over so the bottom flange rested against the bottom of the split webs of the panels, spreading the panels and welding them to the edge of the rail.

No stringers or bottom lateral systems were required, for the panels were welded together as a unit between expansion joints, providing ample lateral stiffness, and are self-supporting between floorbeams. The edges of the floor were welded to the Z-bar lower chords for additional stiffness. On the south side of the structure cantilevered floorbeams carried a wooden sidewalk. This was replaced by an all-welded walk with a steel plate floor covered with ¼ in. of lava rock.

Another innovation was the use of shallow arch-web steel sheeting as the bridge roadway guardrail. This rail is set about car-wheel level, is welded at the top to the truss members and at the bottom to short blocks which give the exposed surface of the sheeting a slight pitch, as shown in Fig. 3. An H-beam set 3 ft. 8 in. above the floor completes the guard system.

The shore ends of the sidespans were raised 2 ft. 8 in. and 5 ft. 8 in., respectively, to clear the rocker bents and thus permit full widening of the roadway at these points. By use of the panel flooring, the raising was done without stopping traffic.

The job was an unusually safe one for the traveling public and worker alike. Each welder and burner had a helper standing by with a fire hose or fire extinguisher. All welding and burning was stopped during passage of a gasoline truck over the roadway or a tanker under the bridge. A screen protection was built under the top lateral system during erection of the new trusses and dismantling of the old. One cracked windshield from a welding spark was the sole public damage.

Direction

At the start of reconstruction the bridge was owned by the Steubenville, East Liverpool and Beaver Valley Traction Co. C. A. Smith, president, and H. R. Frederick, general manager, planned the improvements. However, before the job was completed, the structure was purchased by the State Bridge Commission of Ohio, Nick Stevens, chairman.

C. M. Neeld, of Pittsburgh, was engineer and contractor. Robinson & Steinman, New York, were consulting engineers.

Raising O'Shaughnessy Dam

Contents in Brief — An addition to O'Shaughnessy Dam on San Francisco's water supply system involved bonding new concrete to seasoned concrete already under load, and making the combination react as a homogeneous structure.

WHEN ADDITIONAL HEIGHT was required on O'Shaughnessy Dam, an arched structure of gravity section that develops water storage in Hetch Hetchy Valley for San Francisco, the new work included bonding fresh concrete to the old, curved downstream face. This bond was to be made, if possible, in such a way that the enlarged structure would act under stress just as if it had been built originally to the final dimensions. Features of design and construction which have contributed to what is believed to be an entirely satisfactory solution of this problem are outlined in the following. The addition to the dam provides a 75 per cent storage increase that is to meet both water and power requirements for some time to come.

When the original dam was planned the full section for the additional height was brought up to streambed level (El. 3500). Here the thickness was decreased 80 ft. in one step and above this level the thickness was only that necessary for the original height. An exception to the thin section was made in the portion of the structure containing six outlet conduits: here the section was built initially to ultimate thickness.

The downstream face of the thin section was stepped to facilitate bonding when the addition was put on. The initial structure, completed in 1923, was curved to a 700-ft. radius and had a crest length of 605 ft. Statistical data are given in Table I and more details can be found in *ENR* April 26, 1923, p. 741.

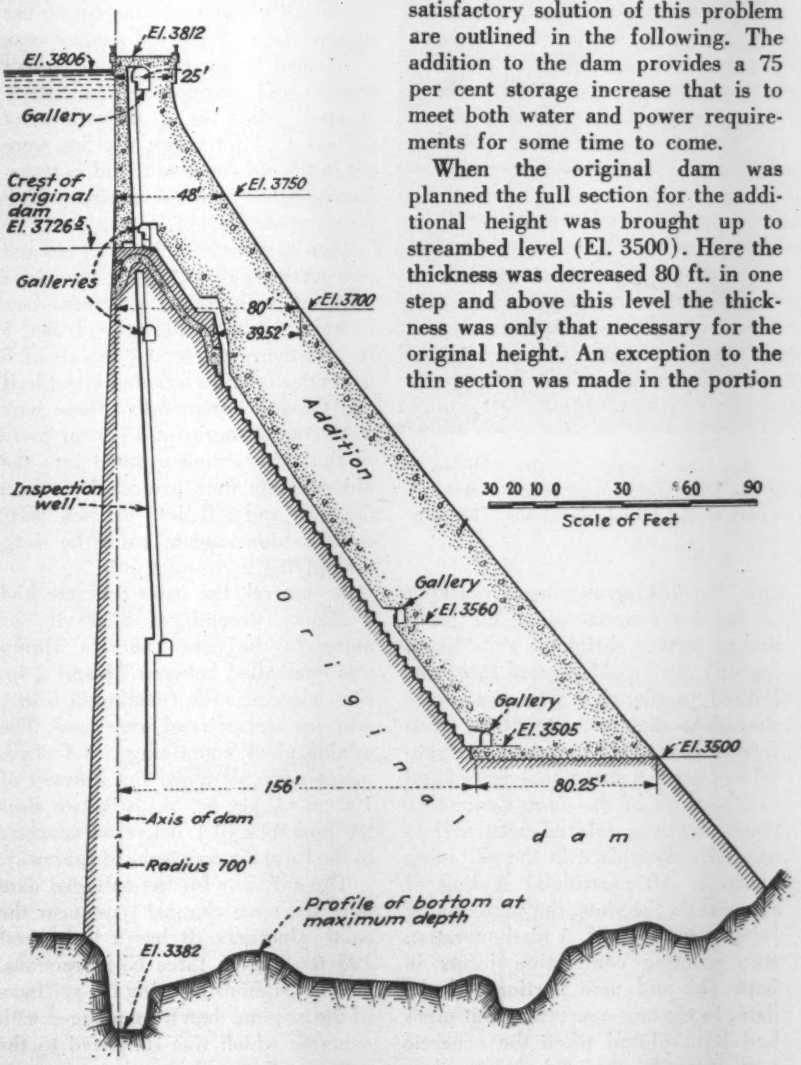

Fig. 1. Typical radial section of O'Shaughnessy Dam showing original work and recent addition.

A homogeneous addition

Throughout the additional concrete, which extends 85.5 ft. above the old crest, the radial contraction joints average 50 ft. apart, about half the spacing used in the old portion of the dam. Thorough drainage was provided for, especially along the joint between old and new concrete: drains discharge into gutters in the inclined inspection galleries.

When the addition was begun it was assumed that all shrinkage incidental to setting and cooling in the old concrete had taken place. It was considered possible that if the addition were made by simply pouring new concrete against the old, without special precaution to secure proper transfer of stress between old and new concrete, stresses resultant from water level substantially above the original crest elevation might seriously overload the older portion of the dam. Hence an important objective in making the addition was to give the new concrete the same strength and modulus of elasticity as the old, if possible, within the construction period and also to provide for adequate distribution of stress.

Important factors in accomplishing this were (1) the superior concrete that can be produced in a modern plant and with modern knowledge as compared to the best that could be made using substantially the same cement content when the original structure was built; (2) artificial cooling of the concrete with the aid of a refrigerating plant, which was a provision making possible (3) early effective grouting.

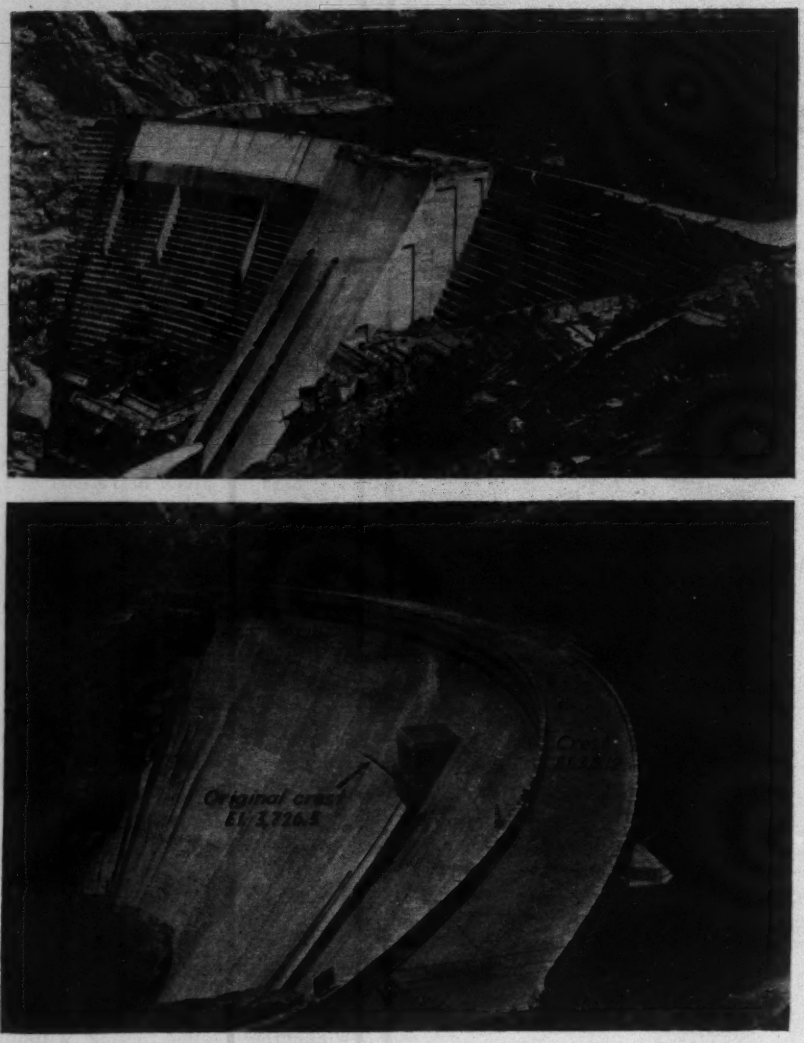

Fig. 2. Original O'Shaughnessy Dam, at the top. New concrete for the addition is in place below the siphon spillway outlets at the left. The central block containing the outlet pipes was built to full thickness as part of the initial operations. The completed dam is shown in the lower view.

The cooling pipes, chiefly 1 in. in diameter, were embedded in the concrete in horizontal layers 5 ft. apart vertically; in each layer the pipe spacing was 5.5 ft. The first cooling water for each section was taken directly from the reservoir; later, wherever colder water was essential to the desired cooling rate, reservoir water cooled in the refrigerating plant before circulation was used.

The larger part of the additional concrete placed on the downstream face was not poured directly against the old structure. Slots with an average thickness of 5 ft. and a length of 20 ft. were left open along the joint between old and new concrete; only narrow ribs (2 ft. thick) sufficient to support the weight of the new concrete were allowed to make direct contact. By this arrangement, cracking of the new concrete along the joint, due to vertical shrinkage and "hanging up" on the old stepped face, was limited to the ribs. The slots were shaped so that concrete filling them formed keys to transmit both horizontal and vertical stress between old and new sections of the dam. Concreting these slots was delayed until shrinkage had taken place in the adjoining concrete. After artificial cooling of concrete in the slots, the surrounding joints were grouted. A final operation was grouting contraction joints in both old and new portions of the dam. In the new concrete, grout pipes had been placed when the concrete was poured; the old joints were reached with grout through holes drilled at convenient locations.

In preparing the abutments for the new concrete it was expected at the outset that about 30,000 cu.yd. of rock would have to be excavated. Actually some 85,000 cu.yd. was removed before all authorities were satisfied that seams and fissures had been cut away to full depth and all menace in overhanging blocks had been removed.

Construction operations

In construction operations on the downstream face, concrete was placed with unusual care. Vibrators were used in each batch. For successive 5-ft. lifts in each block there was a 72-hr. minimum time interval and for adjacent blocks a 15-ft. maximum height differential. As 5-ft. lifts were completed sprinklers kept fresh surfaces wet.

Before concrete pouring began the stepped face of the old surface was roughened to improve bond; where stresses of considerable magnitude crossed joints in a direction not normal to joint faces, notches were cut in the old concrete to aid in transferring stress and to eliminate high shearing stresses in joint planes. To further increase bond between old and new sections, 1¼-in. square steel bars were set in the old downstream face in holes 2¼ in. in diameter drilled 5 ft. into the concrete at intervals of 5 ft. vertically and averaging about half this spacing horizontally. These bars were cut in lengths of 15 ft. or more so that after being grouted into the old concrete they projected through the slots and 5 ft. into the new mass concrete downstream from the slots, thus giving a strong bond.

In general, the mass concrete had a 28-day strength of 2,500 lb. or more. In the mass concrete, slump was controlled between 1½ and 2 in. Four sizes of rock (maximum 6 in.) and one size of sand were used. The mixing plant, containing two 4-cu.yd. mixers, was designed for delivery of 100 cu.yd. per hr. Skips in two sizes (4- and 8-cu.yd.) delivered concrete to the form via an overhead cableway.

The spillway for the enlarged dam is of the open channel type, near the south abutment. It has a weir crest 195 ft. long in three 65-ft. sections. The old siphons forming the spillway of the original dam were plugged with concrete which was subjected to the same cooling and grouting processes used elsewhere.

Enlarging the dam was a project of

TABLE I—STATISTICAL DATA FOR O'SHAUGHNESSY DAM

	Year completed	Height in feet: Above streambed	Height in feet: Above lowest concrete	Concrete (cu.yd.)	Reservoir storage (acre-ft.)	Full reservoir water depth at the dam (feet)
Initial structure	1923	226.5	344.5	398,000	206,000	220
Addition		85.5		277,000	154,000	
Raised structure	1938	312	430	675,000	360,000	306

the Hetch Hetchy Water Supply, a department of the San Francisco Public Utilities Commission. Plans and specifications were drawn under supervision of L. T. McAfee, utilities engineer, acting as chief engineer and manager; M. M. O'Shaughnessy (died Oct. 12, 1934) was consulting engineer; Leslie W. Stocker, chief civil engineer; R. L. Allin, hydraulic engineer. J. H. Ryan was resident engineer on construction. Mr. O'Shaughnessy was chief engineer when the original dam was built, and directed the enlargement design.

Plans and specifications were reviewed by the designing staff of the U. S. Bureau of Reclamation (acting in a consulting capacity) and by the Division of Water Resources, State Department of Public Works, which exercises the state's jurisdiction over all dams. Construction was by the Transbay Construction Co., a combination of five contracting concerns, for a bid price of $3,219,965. (Extras brought the total paid contractors to $3,477,000.) Contract for the addition was awarded in April, 1935, and completed in 1938. Progress was limited by the cooling requirements.

Drainage Structure Design

WHAT IS GOOD PRACTICE in manhole catch basin, and curb inlet design? Conditions vary in municipalities, of course, and modifications may be needed to meet some peculiar requirements. In general, however, there are basic principles to be observed and in this connection the standards for drainage structures developed at Utica, N. Y., are worth consideration in any design study.

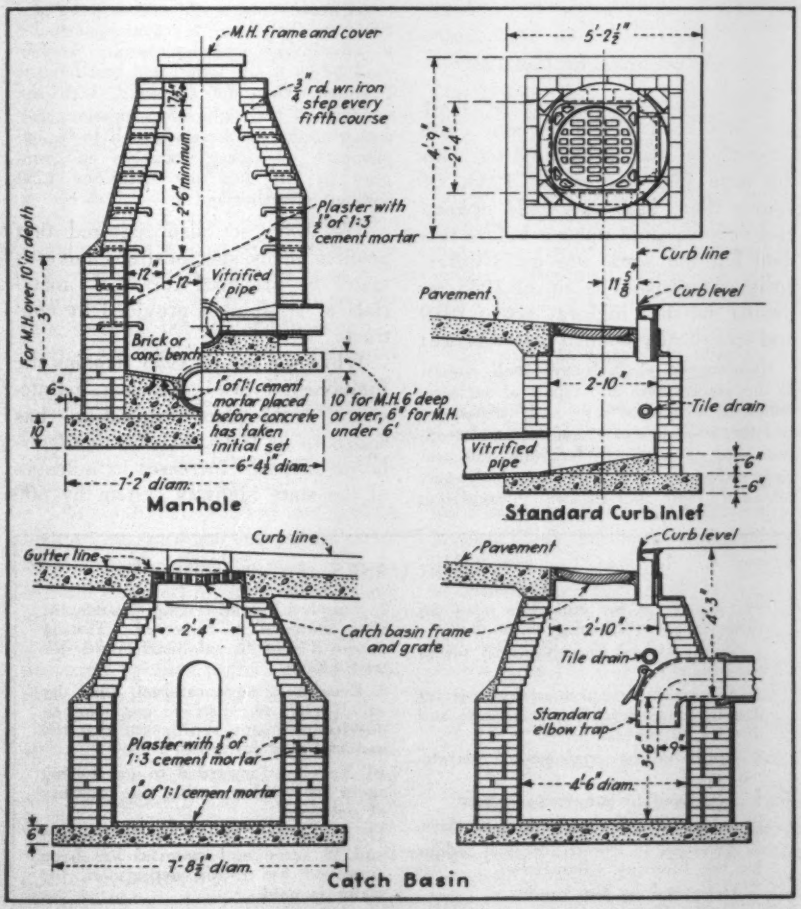

Fig. 1. Design details of drainage structures adopted as standard in Utica.

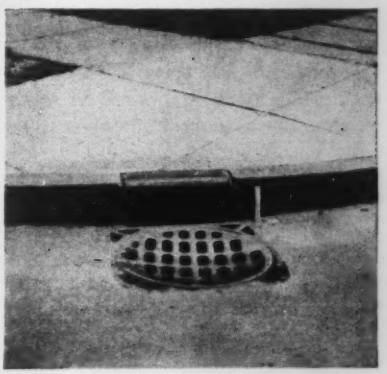

Fig. 2. Typical installation of a curb inlet at a steel intersection.

Most of the streets in Utica are on a flat grade and the city is almost completely paved and curbed.

The accompanying sketches illustrate the present practice in Utica based on many years of experience. Standard manhole design shown in Fig. 1 represents the type of construction adopted for manholes which are divided into two classes—those under 6 ft. in depth and those greater than 6 ft. in depth. The principal differences occur in the thickness of the sidewalls and base.

The design for the standard curb inlet is given in Fig. 1. Particular attention is invited to the use of a sloped bottom which prevents the accumulation of any debris in the chamber.

Also shown in Fig. 1 is the standard design for catch basins. The trapped outlet is provided in places where the basin is connected with the sanitary sewer system, and prevents the return of sewer gas.

The design shown were developed by the Utica engineering department under the direction of Joseph P. Shaw, city engineer.

Road Upkeep—An Audited Business

C. S. HILL
Associate Editor Engineering News-Record

Contents in Brief—By carefully worked out systems of auditing, a multitude of small highway maintenance costs that in the aggregate run to many thousand of dollars are so marshalled as to permit a determination of how expenditures on any highway balance against income from that class of road. Laboratories keep a close check on purchased materials. This is the third of a series of articles on the main elements of highway maintenance work.

SEEING on his travels occasional groups of men at work on small repairs, the road user might reasonably assume that accounting for wages and materials must be in rather general terms, but he would be greatly mistaken. These operations are governed by rigid checks and audit. This control starts with the laws creating state highway departments and specifying their powers and duties. Control at first was simple, but as system mileages came more completely under maintenance and as additions to state road laws put more tasks on maintenance organizations, the procedure became more complex until checks and audit are as fully developed as in any big-business operation. This is equally true of all states, but as in the previous article (*ENR*, May 11, 1939, p. 662), the procedure of one state is presented as a general example.

Indiana is the selected example since its practice represents comparatively recent (1933) maintenance legislation. All maintenance expenditures are deducted from the maintenance service budget which is appropriated biennially by the legislature. All purchases for maintenance originate from requisitions prepared by the sub-district superintendent, approved by the assistant district engineer and signed by the district engineer. When these requisitions are approved by the equipment engineer and the maintenance engineer they go to the purchasing agent who does the buying by securing competitive bids by advertising based on standard invitation to bidders and subject to standard specifications for the material, repairs or supplies in question.

In the maintenance department proper there are two divisions: (1) that which purchases and pays and (2) that which handles the field work; this article considers only the operations that come under checks and audit: budgeting, purchases, charges and records and tests. Since all originate in the requirements of successive additions to the state road laws, the development of this legislation as it applied to road maintenance is outlined first.

As required by law

State road maintenance as it is now organized in Indiana may quite properly be said to have started with the state highway act of 1933. Of course there had been road upkeep and very capable upkeep before this date but the work was quite differently organized. The act of 1933 repealed the state highway act of 1919 and specifically defined maintenance:

> Maintenance of highways shall consist of the preservation and repair of surfaces, roadbeds, rights-of-way and structures, and the development of surfaces and roadbeds and of means to facilitate and promote safety of traffic on such highways; provided that the highway commission may, in its discretion, let any of such work by contract to the lowest and best bidder, after giving notice and taking like bonds as is required by this act in the letting of construction contracts.

A notable clause of this definition was the one providing for maintenance by contract. This is rare practice. In the Motor Vehicle Act, 1937, maintenance is again defined. By these definitions maintenance involves the purchase of materials and equipment. The road law of 1933 tells how they are to be purchased:

> All purchases of tools, implements, machinery, materials and supplies and all contracts for the construction of buildings shall be made pursuant to a system of competitive proposals and contracts, whereby manufacturers or dealers in such tools, implements, machinery, supplies and contracts shall have an equal opportunity to submit bids and the contract therefor shall be let to the lowest and best bidder: Provided, That the chairman, with the approval of the highway commission, may authorize the purchase of small tools, implements, machinery, materials and supplies in any sum not exceeding $250 without advertisement.

The 1933 act also required that profiles, plans, specifications and estimates be prepared for work, materials or equipment provided by contract.

While the act of 1933 remains the fundamental law governing maintenance, subsequent legislation has added to its tasks. Briefly, this legislation includes increases in mileages of the state highway system by 600

PURCHASES

All purchases for materials must go through the following channels:

1. Requisitioned by sub-district superintendent.
2. Approved for purchase by assistant district engineer of maintenance and district engineer.
3. Approved by engineer of maintenance.
4. Approved by purchasing agent.
5. Advertised probably for 10 days.
6. Awarded to lowest and best bidder by the highway commission.
7. Delivered by the vendor.
8. Sampled by the testing department after material is delivered. Testing approval sent to sub-district and district offices.
9. Receiving memorandum sent by sub-district to district engineer to purchasing agent, setting out that the material was delivered.
10. Voucher forwarded to purchasing agent by vendor setting out quantity of delivery.
11. If amounts as set out in items 9 and 10 agree and material has been approved by testing department the claim is paid.

mi. in 1937, 500 mi. in 1938 and to 12,000 mi. by July 1, 1939; approval of the construction of all private approaches to state highways; granting permits for the opening of the surface or right-of-way of state highways; granting permits for the moving of oversize or overweight loads or vehicles; maintenance of state highways through all towns except those of first class, *i.e.*, Indianapolis; marking and signing state roads; operating signals and lights; establishing recreation grounds, one-lane bridge warnings and maximum speed zones, and detour highway maintenance.

A somewhat long account of legislation has been given purposely as it illustrates a common characteristic of maintenance development, that is, continuous additions by law to state mileages to be maintained and increase in number and variety of maintenance duties. Each addition has required extension or alteration in the method of check and audit control which has kept it in a constant state of flux; about the only constant is the principle that checks and audit are vital and must be rigidly exercised.

Execution in detail

The traffic survey classifies state highways as A, B and C roads: A Roads have over 750 vehicles daily; B Roads have over 250 to 750 vehicles daily, and C Roads have below 250 vehicles daily. The maintenance standard for a particular section is determined by the class of road it is found to be by the traffic survey. By this method the expenditures on a section are kept directly proportional to the revenue from the section. Different standards for various maintenance operations are assigned to each class and the budget for the section is set up accordingly.

The methods specified for setting up each account are very exact as indicated by the schedule on p. 710. In general that part of the 1933 highway act which provides that the state highway commission shall cause to be prepared profiles, plans and specifications for all contracts has been especially emphasized. Very detailed specifications are in force on all maintenance contracts, and standard printed specifications are provided for all equipment purchases. These specifications are included in all notices to bidders.

In Indiana, the patrolman is the hub of the wheel of maintenance activity. All instructions for maintenance practices come finally by way of district engineer and sub-district superintendent to the patrolman who puts the instructions into maintenance operations. And then when the patrolman has performed a maintenance task he must classify the operation and record his labor and equipment, time, and the material used on standard "labor and equipment" and "materials used" reports.

A testing laboratory checks the quality of all materials used in maintenance (Ohio).

Each unit of major equipment (trucks, tractors and road machinery) has a number assigned it. All parts used and time spent repairing the unit and the fuel and lubricants consumed by it are charged to the number. The time the unit is worked and the sections of road is recorded by the patrolman. Thus the equipment cost can be distributed to the section.

All work is coded for ease of recording. Work coded in 200 indicates maintenance on state highway section indicated in the block above the hours-worked block opposite the name of the laborer or number of the piece of equipment. In the same manner 300 indicates maintenance of detours and 400 with the number of allocation indicates a betterment charge. In brief the little repair job that the motorist just notices as he passes is nailed down on the maintenance records in dollars, in hours of time and in number of men worked.

A rigid laboratory check

The department of materials and tests, with a central laboratory in Indianapolis and sub-laboratories in six district headquarters, is responsible for testing materials purchased, and no vouchers are passed for payment without the approval of the testing department. During the year ending June 30, 1937, 3,533 samples were tested in the central laboratory for the maintenance department. Each of the six districts handles the testing of plant samples of all aggregates purchased on maintenance contracts. When aggregates are hauled from the plant in trucks, weight tickets from certified scales showing gross tare and net weight and per cent of moisture in the aggregate must be handed by the truck driver to the representative of the highway commission before the load can be spread or stocked on the road. The inspector at the plant sees that the aggregate comes from the approved stockpiles or bins of material. Freight car shipments are not accepted until approved by the engineer of tests.

Conclusion

The money of the road user that goes for maintenance is protected by all the checks and audits that are common in big business operations. A single state has been selected as an example but practice in any of the 48 states presents the fact as clearly. There is no haphazard expenditure of maintenance money because of faulty accounting. In this and previous articles the talk has been of the routine work of road upkeep; this is the vital task but upkeep performs other services and the next article will emphasize one that the road user scarcely realizes—highway landscaping. Incidentally, the reader will find in that article a definition of landscaping that reaches into the geometrical design of roads deeper than he is likely to have imagined.

Common-Sense Blasting Procedure

JOHN JEFFRIES
Technical Representative, Atlas Powder Co., Wilmington, Del.

Contents in Brief — Will you swap 8 minutes for 80 hours? The author asks this question to call attention to the need of precaution in tunnel and shaft blasting where time saved at the expense of a final check-up is often lost many times over when a round fails to pull. This article tells of the latest methods in blasting procedure, exposes certain fallacies in common practice, recommends sound steps in loading and firing.

YOU CONTRACTORS on tunnel and shaft work, will you swap 8 minutes for 80 hours? This sounds like a ridiculous question, but in an actual case, a crew of ten men, after working 8 hr. drilling and loading a shaft round, saved the 8 min. necessary to take proper precautions only to have the shot fail to pull the ground. Thus 80 man-hr. were lost and in addition to the delay of the job the contractor was out $100 for wages and explosives.

Contractors on underground jobs work under the handicaps of ever-changing personnel and of types and locations of operations, far different from stabilized mining work. Many fail to keep abreast of modern blasting methods and attempt to get by with old practices, not realizing that explosives and blasting supplies have changed radically.

Some old-fashioned supervisors believe that a certain number of misfired holes is inevitable on every job, but misfires are largely the result of carelessness. In the following, common errors in blasting practice will be noted, blasting methods will be traced from the source of current through shooting, and ways to improve these practices will be suggested.

Blasting current and switches

On one job, where both 110-volt and 220-volt current were available, the 110-volt source was being used. Current at 220 volts is preferable, and is usually capable of handling the average underground shot. When extremely large numbers of holes are being fired in straight parallel 440 volts may be used to advantage.

Inadequate switches are a common fault. When firing large numbers of electric detonators rapid, positive and complete closing of the switch is essential. A common, but wrong, type of switch is shown in Fig. 1. This switch is the double-pole, single-throw type, closed by pushing the handle against spring tension, and housed in a box so small that the shot-firer cannot avoid barking his knuckles. The spring, barked knuckles and the natural tendency of the blaster to handle a 220-volt switch rather gingerly combine to make the switch contact slow and irregular. As electric caps fire in about 3/1,000 sec., such a switch may cause a portion of the caps to fire and break the circuit by making partial contact before the circuit is completely closed.

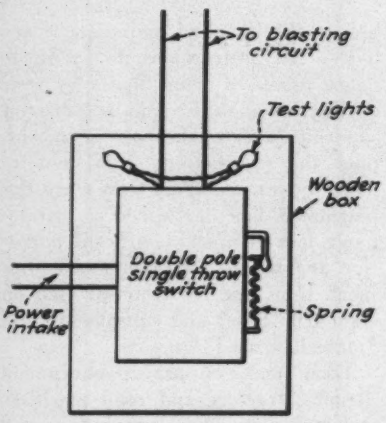

Fig. 1. Common but wrong type of blasting switch, in which the throw is against spring tension.

Another contribution to poor blasting is also illustrated in Fig. 1. Two 125-volt carbon light globes are sometimes connected in series across the outlet to the blasting circuit. If the lights glow brightly when the switch is closed it is considered assurance that the line voltage is adequate. Then the blasting circuit is connected and the switch thrown. The light globes form a parallel circuit of very small resistance compared to the average blasting circuit. Thus a large portion of the line voltage, seeking the path of least resistance, goes through the light circuit while only a small portion is available to the blasting circuit. Such a switch installation is conducive to misfires.

A correct blasting switch installation is that shown in Fig. 2. A double-throw, double-pole spring toggle switch is enclosed in a metal case and covered by a larger wooden box (Fig. 2A). The metal case can be locked only when the switch handle is in neutral position, and only the shift boss is allowed to have a key. A powerful spring trips and closes the switch in a positive and rapid contact. A heavy flexible cable is attached to one side of the toggle switch, and test light globes are connected across the other side. The old single-throw switch is placed 10 ft. away, equipped with an intake socket as shown in Fig. 2B.

When a blast is to be made, the flexible cable is plugged into the socket of the old switch, the handle of the toggle switch is thrown down to light the test lights; the handle of the old switch is pushed up against the tension of the coil spring and held closed, and the toggle switch handle is then pushed upward to fire the blast. The two separated switch boxes with no permanent connection make it impossible for one man to fire a blast and provide a "lightning gap" in the outside blasting circuit; and the test lights are removed from any connection with the blasting circuit.

The lead wire from the blasting switch to within 100 ft. of the face should be No. 8 or heavier, rubber-covered wire. On shaft work additional pieces of lead wire are sometimes spliced on as the shaft is sunk

deeper, resulting in a lead of different kinds of wire improperly spliced. Such firing facilities often lead to broken joints and delays.

Such conditions may be remedied by securing a No. 8 duplex rubber-covered cable long enough to reach the ultimate bottom of shaft. The cable can be put on a reel and let down into the shaft through a pipe in the concrete lining to the bottom of the last section of concrete poured. No. 14 single strand wire should be used to connect the cable with the shot. As the shaft is sunk deeper, the cable is unreeled at the top and no splices are necessary. A plug socket is provided for the free end of the cable on the reel so that after all men are out of the shaft the cable can be plugged into the blasting line from the switch.

After a tunnel has been started from the bottom of a shaft, rubber-covered No. 8 wire should be strung on separated insulators as a lead line. At the bottom of the shaft a plug socket should be provided so that the lead line may be disconnected at that point to leave a gap of 10 ft. when final connections are being made at the face. This gap offers protection to workmen if lightning should strike the lead wires on top. The lead line should be kept within 100 ft. of the face, and No. 14 single-strand wire should be used to contact the lead with the shot. Too often the lead wire is allowed to lag behind the advancing face and connecting wire is used to bridge the gap.

When it is necessary to splice lead wires, the joints should be leaded and then taped. After wires have been spliced by twisting, corrosion sets in and soon there is very poor contact. A large number of such splices will add up to a surprising resistance to the passage of current. Some of the splice joints made in a tunnel lead wire could be eliminated by unwinding 500-ft. lengths of wire from a reel, as described for the shaft lead wire.

Handling primers

It is not uncommon for workmen to make primers by forcing electric blasting caps into cartridges of gelatin dynamite that have not previously been punched to provide a hole for the cap. This haphazard method causes improper priming, which may be the cause of misfires and accidents. If a cap is punched into a cartridge of gelatin dynamite in such a way that the cap is skewed across the cartridge, the business end of the cap may be subjected to abrasion on the side of the bore hole as the primer is pushed into place, resulting in a premature explosion. Another bad habit is to place the primer and slit cartridges on the muck pile before loading. Cartridges of explosive and even primers have been lost in the muck in this way.

One man should be responsible for making up all primer cartridges in the proper manner at a point remote from the face, and this same man should see that all cartridges except the primers are slit. After drilling has been completed, the primer cartridges should be delivered to the face in a divided box holding the different numbers of delay electric blasting caps. The slit cartridges should also be delivered to the face in powder boxes made for that purpose.

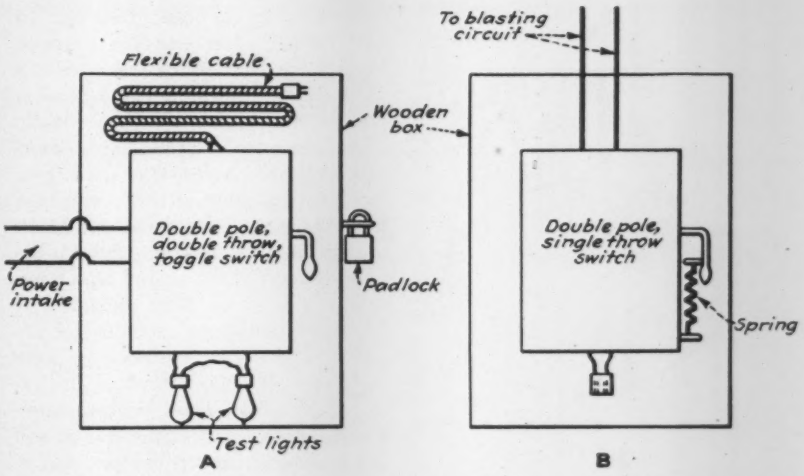

Fig. 2. Correct type of blasting switch, consisting of two switchboxes connected by removable flexible cable.

Loading the holes

A hazardous practice, sometimes used, is to start loading before all holes are drilled out. This is extremely dangerous, for cut holes sometimes intersect and a loaded hole may be drilled into.

The shift boss should place the primer cartridges in the collar of their proper holes to prevent firing out of turn. The primers should be placed deep in the holes to prevent "robbing" or cutting out of primer cartridges and explosive by holes that fire previously in rotation. The primer cartridge is pushed into place with the tamping stick, but should not be tamped until another cartridge has been placed in the hole.

Slit cartridges must be tamped sufficiently to make the explosive fill the hole. The collar of the hole should be tightly stemmed with inert material to secure maximum effectiveness. Furthermore, stemming is a means of holding the explosive in the holes until they fire in their rotation. A mixture of four parts of damp sand and one part clay, loaded in tamping bags, is a satisfactory stemming material.

Electric blasting circuits

Electric blasting caps come equipped with leg wires of various lengths, though those shorter than 12 ft. are not recommended for ordinary tunnel work. Some contractors buy caps with 8-ft. leg wires because they are a little cheaper, but their use is false economy. The short wires do not permit placing the primer cartridge deep in the hole, resulting in "bootleg" or unfired parts of the hole.

To prevent leakage, most manufacturers put a brown enamel insulation coating on all delay electric blasting cap leg wires and on all electric cap leg wires over 10 ft. long. Shorter-length leg wires may also be obtained with this enamel coating. All exploders used in wet work should be equipped with enameled leg wires.

During manufacture, the ends of the leg wires are scraped free of enamel and are dipped in tin to provide for connections. If a leg wire is cut off, the enamel on the end of the remaining length must be thoroughly removed before connecting to another

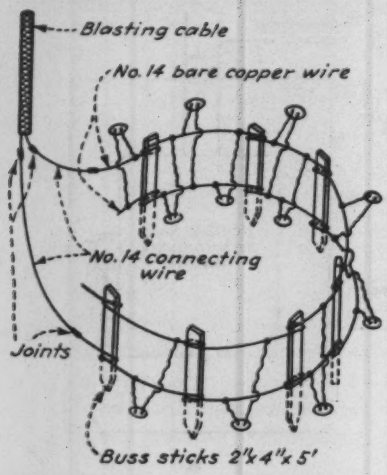

Fig. 3. Buss wire system of connecting blasting caps, suitable for both shaft and tunnel work.

wire. Obviously, to prevent current leakage, the tinned connections must not be allowed to lie in water or to be in contact with wet ground. The smaller the number of exploders connected in any one series, the less likely current leakage is to occur. Contrary to general opinion, increasing the voltage on the blasting circuit will not cure current leakage, the only cure is to insulate connections or see that they are not exposed to water or contact with wet ground.

Three methods of connecting exploders in large shaft and tunnel work are in general use. (The following discussion assumes a firing current of 220 volts). Connecting in straight or single series is the oldest method and when the work is dry, it is safe to connect a maximum of 40 electric blasting caps in one series. If the work is wet, this number can be safely connected in one series only if all connections are adequately insulated. At one large shaft an asphalt of 115-deg. melting point was used for this purpose. After all connections had been made they were rapidly "dunked" in the asphalt, requiring only 6 to 8 min. to insulate all joints in circuits containing 40 to 50 holes.

Straight parallel method

The second method is that of straight parallel or buss wire connections, where each exploder constitutes a separate circuit in which one leg wire is connected to a buss wire and the other leg to a second buss. Fig. 3 shows a buss wire system in a shaft. Wooden buss sticks are driven into drill holes to form points on a circle convenient to all holes. Two No. 14 bare copper wires are then wrapped around the buss sticks and stretched tight about 2 ft. apart. The exploders are securely connected individually across the buss wires at spaced intervals along the wires. One wire from the blasting cable is then connected to one buss wire and the second blasting cable wire is connected to the opposite end of the second buss wire. In this system the total resistance of the circuit decreases as exploders are added, and if one exploder leg wire is broken, it does not affect the remainder of the circuit. Unfortunately a galvanometer test of the system will not indicate a broken leg wire and if the buss wires are short-circuited at any point, the holes beyond that point will misfire.

Some common mistakes causing trouble in blasting with the buss wire system are: The buss sticks may be so small that the wires are not held rigid or so short that it is necessary to place the buss wires close together; if the buss sticks are wet and the wires are close together, the current may arc across the stick to short circuit the system; exploder leg wires are sometimes loosely attached to the buss wires or are bunched together at one point, resulting in uneven distribution of current and misfires; buss wires may touch water or wet ground, also causing a short circuit and misfires. The buss wire system is used to fire tunnel faces by driving the sticks in horizontal bore holes and stretching the buss wires across the face.

The third method is a combination of the first two methods, in which two or more short series of caps are connected across the ends of the blasting cable in parallel, known as the parallel-series connection. This method has the advantage of a low total circuit resistance, like all parallel circuits, with consequent large current flow through the exploders. It has the disadvantage that a galvanometer test of the entire circuit will not indicate a break in one of the individual series. In addition, it is very likely that misfires will occur unless the various series contain about the same number of exploders. The series in this system are susceptible to current leakage with consequent misfires just as was the single series described above unless the proper precautions are taken. Experience has indicated, however, that as long as the series do not contain more than fifteen exploders each, there is little likelihood of trouble from current leakage.

In tunnel and shaft work it has been observed that when the parallel-series connection was used, the usual method is to connect the cut holes in one series, the first reliever holes in a second series, the second reliever holes in a third series, and the ring holes in a fourth series, regardless of the number of exploders in each series. This procedure is conducive to misfires because the firing current is divided among the series in inverse proportion to the resistance of the various series. This means that the smallest series would receive the most current, and, conversely, the largest series would receive the least current. Under such conditions misfires often occur in the largest series. Another common mistake in connecting parallel-series is that of bunching the ends of the series and then hooking to the lead wire. This gives uneven distribution of current and sometimes results in misfires. The ends of the various series should be connected to the lead wire at spaced points.

Although every shift boss has his own pet system, long observation indicates that less trouble is experienced when the straight parallel or buss wire system is used.

Power and light lines often leak enough current to fire a single exploder, which presents a particular hazard in horizontal bench holes for the ends of the leg wires often dangle in the water while loading. All power and light lines should be shut off at the time loading is started. A storage battery will provide light for loading and the lamps should be kept 25 ft. from the face.

Additional precautions

It is important to keep track of the number of holes drilled to check on the loading and connections. On several occasions holes have been left unconnected after they were loaded; in all probability such unconnected holes would not fire and both powder and caps would be left in the muck. Recently a new cap has been developed that is less sensitive to shock, but still require care in handling.

In conclusion, it seems obvious that those who are willing to trade an 8-min. check-up for 80 man-hours of work will not only obtain better blasting, but will make greater speed at a lower cost per foot.

Safe Loads for Spiral Columns

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THE TABLE for safe loads on spiral columns as computed by Dr. Jacob Feld and published in *Engineering News-Record*, Nov. 10, 1927, has been revised in the accompanying table in accordance with the requirements of the new building code of New York City. The formulas used in the computations to give loads in kips, or thousand pound units, were as follows:

Grade A concrete:

$$P_c = 0.5(1 + 50p')$$
$$P_s = 7.5A_s$$

Grade B concrete:

$$P_c = 0.625(1 + 50p')$$
$$P_s = 9.375A_s$$

in which p' is the spiral steel ratio, or $4a_s/(d_cS)$ and A_s is the area of the longitudinal steel; a_s is area of spiral, d_c is diameter of core or spiral (outside), and S is the pitch of the spiral.

The maximum longitudinal steel is limited to $0.04A_g$ or to 4 times the volume of spiral steel, with A_g= gross area of column. This means that $A_{s\ max.} = 4a_s\pi d_c/S = 12.57\ a_s d_c/S$. This controls for small spiral steel areas. The minimum vertical steel is $0.0075A_g$.

The maximum allowable load for any column is $2f_cA_g$. Hence for Grade A concrete, with f_c of 500 lb. per sq. in., the maximum load in kips is A_g and for Grade B concrete, with f_c of 625 lb. per sq. in., the maximum load is 1.25 A_g. These maximum loads are indicated in the table.

Using the table

The total load for any column is of course the sum of P_c and P_s, but must never exceed the value given as $P_{max.}$; as spiral steel is more effective than vertical steel, it is economical to use minimum vertical steel or rods not much heavier than minimum. To facilitate the choice of vertical steel, the table gives safe loads P_s in kips for any number of rods.

LOADS IN KIPS FOR SPIRAL COLUMNS — NEW YORK CODE

Core Dia. and Area A_c	Spiral Steel: Dia. in.	Pitch in.	% Spiral	Wt. per ft.	Grade A Concrete: Load P_c Core	Max. vert. steel P_s: Rods	Load	Min. vert. steel P_s: Rods	Load	Grade B Concrete: Load P_c Core	Max. vert. steel P_s: Rods	Load	Min. vert steel P_s: Rods	Load
12 in. and 113 sq. in.	¼	1⅝	1.01	3.9	85	6-1 " rd.	35	5- ⅝" rd.	11	106	6-1 " rd.	44	5- ⅝" rd.	14
	⅜	1⅞	1.96	7.6	112	8-1 " sq	60			140	8-1 " sq.	75		
16 in. and 201 sq. in.	¼	2½	0.49	3.4	125	9- ¾" rd.	30			156	9- ¾" rd.	37		
	¼	1⅞	0.66	4.5	133	7-1 " rd.	41	8- ⅝" rd.	18	167	7-1 " rd.	51	8- ⅝" rd.	23
	⅜	2¼	1.22	8.4	160	8-1⅛" sq.	76	or		202	8-1⅛" sq.	95	or	
	⅜	1⅞	1.47	10.0	174			6- ¾" rd.	20	218			6- ¾" rd.	25
	⅜	1⅝	1.69	11.6	185	8-1¼" sq.	94			232	8-1¼" sq.	117		
	½	2½	1.97	13.4	199		$P_{max.} = 314$			250		$P_{max.} = 393$		
20 in. and 314 sq. in.	¼	2	0.49	5.3	195	8-1 " rd.	47			244	8-1 " rd.	59		
	¼	1½	0.66	7.0	209	7-1½" sq.	66			261	7-1½" sq.	87		
	⅜	2¼	0.98	10.5	234	8-1¼" sq.	94			292	8-1¼" sq.	117		
	⅜	1¾	1.26	13.5	256			8- ¾" rd.	26	320			8- ¾" rd.	33
	⅜	1½	1.47	15.7	272					340				
	½	2¾	1.43	15.3	269	12-1¼" sq.	140			336	12-1¼" sq.	176		
	½	2¼	1.74	18.7	293					367				
	½	2	1.96	21.0	311		$P_{max.} = 452$			388		$P_{max.} = 565$		
24 in. and 452 sq. in.	¼	1⅝	0.50	7.8	282	9-1 " sq.	67			353	9-1 " sq.	84		
	⅜	2½	0.73	11.3	308	9-1¼" sq.	105			385	9-1¼" sq.	131		
	⅜	1⅞	0.98	15.2	337	12-1¼" sq.	140			421	12-1¼" sq.	175		
	⅜	1½	1.23	18.9	365	15-1¼" sq.	175	8- ⅞" rd.	36	456	15-1¼" sq.	218	8- ⅞" rd.	45
	½	2⅝	1.24	19.2	366			or		457			or	
	½	2¼	1.45	22.4	390			6-1 " rd.	35	487			6-1 " rd.	44
	½	1⅞	1.74	26.9	422					528				
	½	1⅝	2.02	31.0	454	20-1⅛" sq.	190			568	20-1⅛" sq.	237		
	⅝	3	1.70	26.2	418					522				
	⅝	2⅛	1.94	30.1	443		$P_{max.} = 616$			556		$P_{max.} = 770$		
28 in. and 616 sq. in.	¼	1⅝	0.51	10.7	387	10-1⅛" sq.	95			483	10-1⅛" sq.	119		
	⅜	2½	0.74	15.6	422	12-1¼" sq.	140			527	12-1¼" sq.	175		
	⅜	1⅝	0.97	20.4	457					572				
	⅜	2⅞	0.97	20.5	457	16-1¼" sq.	187	10- ⅞" rd.	45	572	16-1¼" sq.	233	10- ⅞" rd.	56
	½	2¼	1.24	26.2	499	20-1¼" sq.	234	or		624	20-1¼" sq.	292	or	
	½	1⅞	1.49	31.4	537			8-1 " rd.	47	672			8-1 " rd.	59
	½	1⅝	1.72	36.2	573					716				
	⅝	3	1.46	30.6	533	21-1¼" sq.	246			666	21-1¼" sq.	307		
	⅝	2½	1.75	36.8	574					722				
	⅝	2¼	1.95	40.9	608		$P_{max.} = 804$			760		$P_{max.} = 1005$		
32 in. and 804 sq. in.	⅜	2¾	0.50	13.8	503	13-1⅛" sq.	123			628	13-1⅛" sq.	154		
	⅜	1⅞	0.73	20.2	549	15-1¼" sq.	175			686	15-1¼" sq.	219		
	½	2½	0.99	26.9	601	20-1¼" sq.	234			751	20-1¼" sq.	292		
	½	2	1.23	33.6	649			10-1 " rd.	59	812			10-1 " rd.	73
	½	1⅝	1.51	41.3	705					882				
	⅝	2⅝	1.46	40.0	695	26-1¼" sq.	305			868	26-1¼" sq.	381		
	⅝	2¼	1.70	46.8	744					928				
	⅝	2	1.92	52.6	787		$P_{max.} = 1018$			984		$P_{max.} = 1273$		
36 in. and 1018 sq. in.	⅝	2½	0.49	17.0	634	13-1¼" sq.	152			792	13-1¼" sq.	190		
	⅝	1⅝	0.75	26.2	700					875				
	½	3	0.72	25.2	692	20-1¼" sq.	234			865	20-1¼" sq.	292		
	½	2¼	0.96	33.6	753	26-1¼" sq.	305	12-1 " rd.	71	942	26-1¼" sq.	381	12-1 " rd.	88
	½	1¾	1.24	43.2	825					1030				
	½	1½	1.45	50.4	878	32-1¼" sq.				1097	32-1¼" sq.			
	⅝	2¼	1.51	52.7	893	50.0 sq. in.	375			1117	50.0 sq. in.	468		
	⅝	2	1.70	59.0	942					1177				
	⅝	1¾	1.95	67.5	1005		$P_{max.} = 1257$			1256		$P_{max.} = 1570$		
40 in. and 1257 sq. in.	⅝	2¼	0.50	21.0	785	20-1⅛" sq.	190			982	20-1⅛" sq.	237		
	⅝	1½	0.73	31.5	857	24-1¼" sq.	282			1072	24-1¼" sq.	352		
	½	2⅝	0.74	32.0	860	25-1¼" sq.	293	9-1⅛" sq.	85	1076	25-1¼" sq.	366	9-1⅛" sq.	107
	½	2	0.98	42.0	935	32-1¼" sq.	375	or		1170	32-1¼" sq.	468	or	
	½	1⅝	1.21	51.8	1008			12-1" sq.	90	1260			12-1" sq.	113
	⅝	2	1.53	65.7	1108	38-1¼" sq.	445			1386	38-1¼" sq.	556		
	⅝	1¾	1.75	74.8	1178					1473				
	⅝	1½	2.04	87.5	1262		$P_{max.} = 1520$			1586		$P_{max.} = 1900$		

LOADS FOR VERTICAL STEEL — KIPS

No.	With Grade A Concrete $P_s = 7.5\ A_s$: ⅝" rd.	¾" rd.	⅞" rd.	1" rd.	1" sq.	1⅛" sq.	1¼" sq.	With Grade B Concrete $P_s = 9.375\ A_s$: ⅝" rd.	¾" rd.	⅞" rd.	1" rd.	1" sq.	1⅛" sq.	1¼" sq.	No.
1	2	3	4	6	7	9	12	3	4	5	7	9	12	15	1
2	4	7	9	12	15	19	24	6	8	11	14	18	23	29	2
3	7	10	13	18	22	28	35	8	12	16	22	28	35	44	3
4	9	13	18	23	30	38	47	11	16	22	29	37	47	59	4
5	11	16	22	29	37	47	59	14	20	28	36	47	59	73	5
6	14	20	27	35	45	57	71	17	25	33	44	56	71	88	6
7	16	23	31	41	52	66	83	20	29	39	51	65	83	103	7
8	18	26	36	47	60	76	94	23	33	44	59	75	95	118	8
9	20	29	40	53	67	85	106	26	37	50	66	84	107	132	9
10	23	33	45	59	75	95	118	29	41	56	73	94	118	147	10

New Design Cuts Cost Of Roller Gates

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Contents in Brief—New roller gate designs are described which give a reduction in chain pull, in weight of gate and in volume of gate pier due to design of roller with the apron at the top. Graphs of resultant forces for new and old designs also are given as is a list of roller gate installations in the United States.

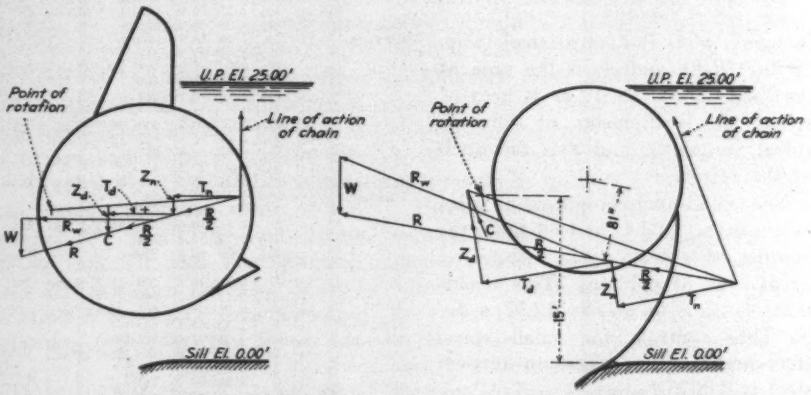
A DESIGN has been developed for a roller gate having the apron at the top that cuts manufacturing and installation costs about 30 per cent and adds highly desirable mechanical features to this popular type of crest gate of which nearly 150 (see table) have been installed in the United States, mostly in the last few years. The accompanying graphs present clearly, by comparison with present designs, the claims of the new gate. Stated for the general reader, and considering a gate 80 ft. long and having a damming height of 25 ft., the broad differences are:

	Old	New
Weight of drum, lb....	360,000	260,000
Drum diameter, ft.....	16½	18½
Rolling circle, ft.....	18½	16
Chain pull, lb.....	360,000	176,000

As shown, the weight of material saved by the new gate in the rotating parts is 100,000 lb., and the chain pull is reduced 184,000 lb. With the saving in weight of the rotating parts is a simplified design which reduces the manufacturing costs; a similar saving results from reducing the chain pull.

These savings of the new design are produced by balancing the forces acting on the drum and apron. An apron placed on the bottom of the drum in the old design was not a matter of choice but one of necessity, so that the gate would be self-closing. This location has been recognized as objectionable because the apron had to be designed for the heaviest pressures upon it, had to be raised into the water flow on opening and was the cause of the heavy chain load. Its location and operating requirements necessitated a heavy construction. In comparative recent times there have been some gates with both top and bottom aprons; this construction has reduced the chain pull and has proven desirable in submergible-type gates.

The real solution of the problem is to eliminate the bottom apron and place the apron on top of the drum where it can be made light and consequently will cost less. The problem of balancing is solved by adding an extension on the lower upstream por-



Nomenclature	Loads in Lbs. New Gate raised 4 ft.	Old Gate in closed position
C, chain pull	173,000	348,000
Z_d, tooth load, driven end	50,000	640,000
Z_n, tooth load, non-driven end	123,000	300,000
T_d, track load, driven end	423,000	869,000
T_n, track load, non-driven end	423,000	790,000
R_w, resultant water load	843,000	1,797,000
Eccentricity of resultant, inches	1½	81

W equals weight of gate and R is the resultant of R_w and W

Fig. 1. Comparative weights, loads and forces in new and old designs of roller gates.

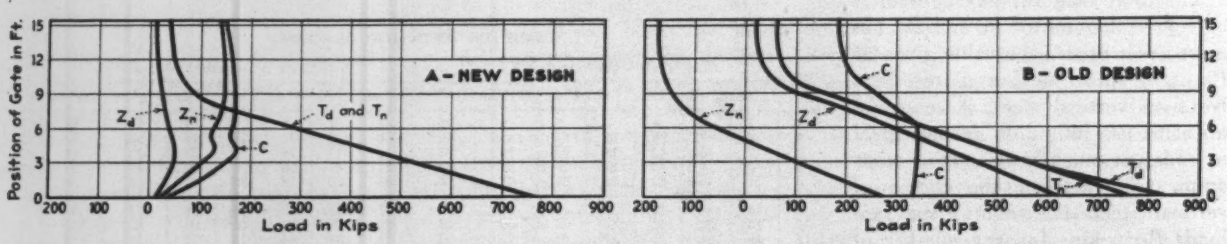


Fig. 2. Magnitude of resultants for new and old design of roller gates, load in kips (1,000 lb.); nomenclature as in Fig. 1.

ROLLER GATE INSTALLATIONS IN THE UNITED STATES AS OF MARCH, 1939

	Number Gates	Length, ft.	Height, ft.
Grand River Dam	6	70	10¼
Grand Valley, Colo.	1	60	15½
Lake Wallenpaupack Dam			
Hawley, Pa.	2	67	14
Clearwater River Dam			
Lewiston, Idaho	3	105	18½
Connecticut River Dam			
Bellows Falls, Mass.	2	115	18
U. S. Bureau of Reclamation:			
All American Canal, Calif.	4	75	23
Rosa Diversion Dam, Wash.	2	110	15½
Penobscot River Dam			
Millinocket, Me.	1	92	19
Upper Mississippi River dams:			
Red Wing, Minn.	4	80	20
Alma, Wis.	6	60	20
Fountain City, Wis.	6	60	20
Winona, Minn.	5	80	20
Trempealeau, Wis.	5	80	20
La Crosse, Wis.	5	80	20
Genoa, Wis.	5	80	20
Lynxville, Wis.	5	80	20
Guttenberg, Iowa	4	80	20
Dubuque, Iowa	3	100	20
Bellevue, Iowa	3	100	20
Clinton, Iowa	3	100	20
LeClaire, Iowa	4	100	20
Rock Island, Ill.	2	100	21¾
	9	100	26
Muscatine, Iowa	4	80	20
New Boston, Ill.	3	100	20
Burlington, Iowa	3	100	20
Canton, Mo.	3	60	20
Quincy, Ill.	3	100	20
Saverton, Mo.	3	100	25
Cap au Gris, Mo.	3	100	25
Alton, Ill.	3	80	25
Ohio River Dams:			
Gallipolis Dam, Ohio	8	125½	29½
Montgomery Island Dam, Pa.	10	100	16
Kanawha River dams:			
London Dam, W. Va.	4	100¼	26
Marmet Dam, W. Va.	4	100¼	26
Winfield, W. Va.	5	100	26
	146		

tion of the drum to offset the overturning moment caused by the water pressure acting on the top apron. This extension also serves as a sealing strip along the bottom of the gate and further, it provides an improved discharge orifice for the water discharging underneath the gate. Once a means was found for balancing the gate with the apron on top of the drum, a whole successive line of changes was opened.

The key point to the new design lay in the moving of the apron from the lower to the upper side of the drum. Fig. 1A shows the resultant action of the water in combination with the weight of the new gate when the gate is in the position of maximum chain pull. Fig. 1B shows the resultant of forces for a gate of the old design in closed position. The chain pull on the old design increases only a small amount for raised positions and the closed position is used better to illustrate the eccentric loading on the drum in the position of maximum stress.

The graphs Fig. 2 show comparative forces for the two designs of gate for all positions from closed to raised 15 ft., or to a raised position where the forces become about constant. The gate chosen for this comparison is 80 ft. long between piers and 25 ft. total damming height. The design figures for the old design were used in the construction of a gate now in service, and the comparable design features for the new gate were prepared by similar engineering methods.

Vacations for Construction Men

VACATIONS for regular per diem employees in the general construction department of the Pacific Gas and Electric Co. (California) were put into effect Jan. 1, 1939. The plan has been worked out for the benefit of steady, per diem workers. A prerequisite, of course, was a plan of operation flexible enough to apply to a construction organization which faces the usual requirements for keeping progress up to schedule during the vacation season.

The vacation allowance is at the rate of five-twelfths of a day for each 22 days worked in the first year and ten-twelfths of a day for each 22 days worked in subsequent years. Vacations are granted on the above basis for time worked in the preceding calendar year. This plan makes it possible to notify an employee on Jan. 1 what his time-off allowance will be in the coming year. Thus it is possible to plan ahead and to make each vacation fit with the work schedule and the absences of other employees so as to avoid interference with the construction program. If exigencies of the job make it impracticable to approve leave for certain individuals during any year, the vacation allowance accumulates and may be taken later at any convenient time. However, employees will not be permitted to forgo vacations for the purpose of receiving extra pay in lieu thereof. In computing time worked, no deduction is made for days off on account of holidays falling on scheduled work days, nor for days absent on vacations.

Those eligible for vacations under this plan are per diem employees of the general construction department who have completed at least one year of continuous service, that is, have worked at least 230 days in a 12-mo. period. After the first year of continuous service employees do not lose their continuous-service status unless they are (1) discharged, (2) voluntarily terminate their employment, or (3) are laid off by the company because of lack of work. When an employee leaves the company's service with an accrued vacation allowance to his credit, he is paid in cash for the vacation time credited as of the date of leaving. Such vacation payments are computed on the basis of the average daily earnings during the calendar year for which the vacation is allowed.

Road Surfaces For Lighting

C. A. B. HALVORSON

Consulting Engineer, General Electric Co., Lynn, Mass.

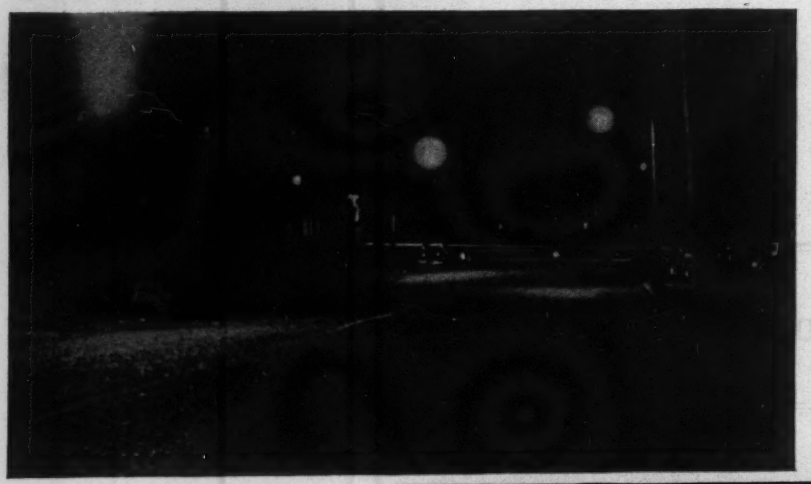
Contents in Brief—Following discussion based on laboratory tests of road surfaces designed for lighting in* Engineering New-Record, *Oct. 21, 1937, the author now presents results of comparative tests on a Lynn, Mass., city street.

CONTRASTING illumination of a city street as regularly paved and after being surface-treated for better lighting is illustrated by the accompanying views. The test was made on Eastern Ave., Lynn, Mass. The original pavement was an open-type, bituminous macadam with a black surface of the semi-diffusing type, having the minimum value of reflectance. The illumination was provided by modern luminaires spaced 110 ft. apart and fitted with 400-watt Mazda lamps. As shown by the *before* view, the lighted surface appears as small spots of brightness alternating with large splotches of darkness. Four targets 4 ft. square having their surfaces painted vertically, half white and half black, were placed in the travel lanes on both sides of the roadway at distances of 100 and 200 ft. from the observers. The white portions of all four targets, because of their high reflectance and brightness, were easily perceived. In only two cases was it possible to see the black target areas and in both the black halves of the targets were seen because they were against the relatively bright areas of the pavement.

The same pavement was then resurfaced with Chelmsford granite chips, ½ to ¾ in. in size, glued to the old pavement with a thin layer of asphalt. This produced a diffusing or matte-surface pavement of about 30 per cent reflectivity. Lighting conditions were the same as in the previous test, and the targets were placed in the same positions as before in left- and right-hand lanes of the highway. In this case, the pavement surface appeared bright throughout and the black areas of all four targets were clearly visible. There were no areas of darkness wherein objects could be partially concealed.

Measurements show that night lighting, directed uniformly on this surface from overhead, reflected uniformly over its whole area. In bright sunlight the surface was found to be appreciably less bright, when facing the sun, than an ordinary dark pavement having a high degree of specular reflection. Still another great advantage was found when the pavement floor was covered with water, as it would be during a rain. The surfaces appeared uniformly bright due to the sides of the chips standing above the water film. With lighting from automobile headlamps alone the visibility distance was increased several times. Under a cloudy sky the pavement appeared uniformly bright.

The tests were carried out by the city officials, a joint committee of the Asphalt Institute and the Illuminating Engineering Society, and the author.



The "before" picture (above) shows the bituminous-macadam pavement which covered the street, and which absorbed a large percentage of the overhead illumination. The "after" picture (right) shows the visibility improvement obtained by resurfacing the street with Chelmsford granite chips, which produce a diffusing pavement of about 30 per cent reflectivity.

Soft Water Will Pay in St. Paul

ROSS A. THUMA

Superintendent, Filtration Plant, St. Paul, Minn.

Contents in Brief *— By softening Mississippi River water with lime, remarkable savings in soap—equivalent to six times the cost of treatment—have been determined in experiments carried out at the St. Paul filtration plant. Details of the experimental plant and the methods used in reaching this conclusion are given.*

AN experimental softening plant at the filtration plant of the St. Paul, Minn., waterworks has shown that Mississippi River water can be made the equal of Lake Superior water in softness at a cost of $5.25 per million gallons over existing treatment costs. Total hardness can be reduced 66 per cent and this in turn will reduce soap consumption by 6 lb. per capita per year, equivalent to an estimated saving of $1 per consumer. Roughly, by investing $1 in softening treatment the return is $6 each year. Based on these findings, provision will be made for lime-softening treatment in connection with improvements now being made. Comparison was made with Lake Superior water because the latter is considered as satisfactory water.

St. Paul procures its water supply from the Mississippi River some 20 miles upstream from the city. Water pumped from the river at the rate of 20 to 35 m.g.d is conveyed to a filtration plant via a 60-in. conduit, and then through a chain of four lakes of 5 million gallons capacity, interconnected by canals. A predominantly limestone watershed produces a medium hard water ranging from 156 to 226 p.p.m. total hardness. Of this total the permanent hardness ranges from 16 to 53 p.p.m.

Treatment at the filtration plant involves the addition of 21 p.p.m. of aluminum sulphate rapidly mixed into the incoming water by air, 45 min. of slow mixing in an under-and-over baffled basin, retention for 6½ hr. in a coagulation basin at the end of which 0.225 p.p.m. of ammonium sulphate is applied prior to filtration. Chlorine at the rate of 0.95 p.p.m. is added to the effluent. These figures are average for the year ending October, 1938. This kind of treatment costs $2.90 per m.g.

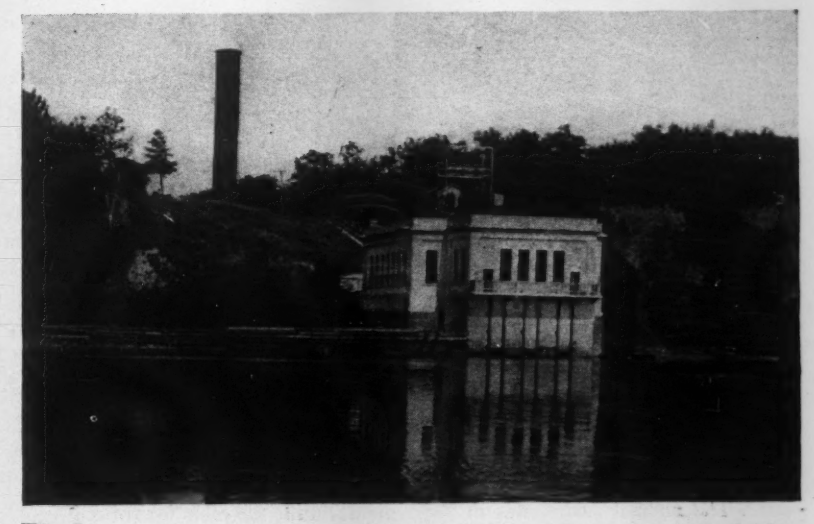


Fig. 1. St. Paul pumping station which lifts Mississippi River to a chain of lakes.

Experimental softener

The experimental softening plant used for the tests had a capacity of 12,000 g.p.d. It consisted of a baffled mixing chamber, clarifier, recarbonation chamber, secondary settling basin and a filter.

Water was pumped from the raw water conduit to a storage tank located somewhat above the elevation of the mixing chamber. A standard lime solution was made up in batches of 50 gal. each, assayed, standardized and metered into the water stream by means of rotating buckets which spilled into an effluent chamber a definite amount of lime solution at each rotation. Water was introduced into the mixing chamber (over-and-under type) through a standard orifice. Lime was applied to the water just before the water entered the mixing chamber, and the alum solution was dropped into the mixture of lime and water three minutes later. The retention in the mixing chamber was 30 minutes, at the end of which the water flowed into an improvised clarifier.

After 2¼-hr. retention the water flowed to a recarbonation chamber where carbon dioxide gas was applied. The water then passed to a secondary settling basin with a retention of two hours, and from there to the sand filter. The chemical treatment consisted of an application of 0.64 p.p.m. of alum, 135 p.p.m. of calcium oxide (lime), and recarbonation sufficient to reduce the effluent to a pH of 9.0. The water was sufficiently over-treated with lime to render it sterile.

Referring to Table I, a comparison of the physical qualities indicates that color and turbidity of the river water are much reduced in passing through lake storage but that odor is less affected. Treatment at the filters reduces color and odor to a minimum and eliminates turbidity. The lime-softening process has proved itself somewhat more effective in reducing color and odor than the alum-coagulation treatment.

The alkalinity of the water reaches its minimum in the springtime with

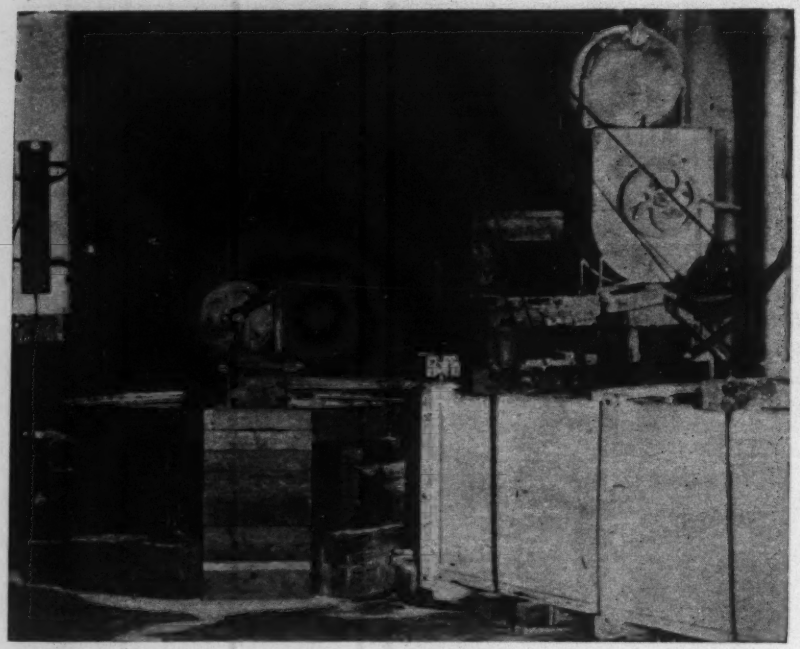


Fig. 2. Experimental softening plant at the St. Paul water purification works.

the melting of the winter snow, hence the water pumped from the river in June was somewhat lower in alkalinity than that pumped into the lakes in the winter months. The lime-softening water treatment reduces the alkalinity of the river water to 40 p.p.m., the same as that of Lake Superior water. The normal carbonates in the river and plant influent change with the season of the year and according to the biological conditions in the lakes.

After the water is treated with alum the normal carbonates are removed from the plant effluent, but in the lime-treated water 30 p.p.m. remain. The pH of the water increased and decreased with the normal carbonates, reaching its maximum in the lime-treated water. Free carbon dioxide is present in the river water and again in the plant effluent as the result of liberation of carbon dioxide by interaction of the alum with bicarbonates.

The calculated hardness of the water shows a reduction by the lime-treatment process equivalent to 118 p.p.m. A comparison of the lime-treated water with that of Lake Superior water shows that the hardness of the latter is slightly lower than that of the lime-treated river water. Bicarbonate hardness of the two waters are the same, but the non-carbonate hardness of the lake supply is somewhat lower than that of the softened river water. The total hardness of the lake water is, however, 9 p.p.m. lower than that of the lime-treated water. The analysis indicates that lime treatment of the Mississippi River water may be depended upon to reduce the hardness to about the same as that of the water of Lake Superior.

Based on results from the experimental units the costs for softening as compared with the present plant are:

	Present	Softening
Coagulant (1938)	$2.22	$0.70
Chlorination	0.57	0.57
Ammoniation	0.11	0.11
Lime treatment	....	5.62
Recarbonation	....	0.25
Sludge removal	....	0.40
Labor	....	0.50
Cost per m.g.	$2.90	$8.15

These figures represent additional cost of plant operation. The capital outlay for building and equipment will be essentially the same irrespective of the type of water treatment practiced. In view of the many additional advantages of lime-treated water, it is felt that the additional cost of water treatment by the lime-softening process is fully justified.

Intangible values

The value of water-softening treatment may be demonstrated in many different directions but not with mathematical accuracy. The data in Table I indicate that the physical, chemical and bacteriological quality of the water is improved by the lime-softening treatment. The color of the water has a tendency to stain the fabrics in the laundry process, thereby requiring more bleach and rinsing.

The reduction of the total solids of the water will lessen the deposit of salts upon evaporation and improve the water for boiler feed purposes. The iron and the manganese content of the water are reduced to a minimum by the lime treatment, thereby eliminating any chance of stain. It is believed, too, that the chlorine content of the water will be somewhat reduced by lowering the chlorine required for sterilization. The amount of aluminum sulphate for coagulation will be reduced to the minimum which will lower the sulphate content of the water by the lime-softening process. Sodium aluminate might be substituted for the aluminum sulphate which would entirely eliminate the addition of sulphates to the water.

The total hardness of the water was reduced 66 per cent and the soap-consuming power 64 per cent. When calculating the savings, however, a number of factors enter as

TABLE I — Comparative analyses of Mississippi River water, lake settled, filter and experimental plant effluents and Lake Superior water for June 1938. (Data in parts per million).

	Mississippi River	Plant Influent	Plant Effluent	Experimental Plant	Lake Superior
Temperature C	21	20	20	20	.....
Odor at 90 deg C	3.5	2.5	0.3	Nil	Nil
Turbidity	12	5	0.0	0.0	10
Color-apparent	164	24	9	6	5
Alkalinity	146	166	151	40	40
Normal carbonates	4	22	0.0	30	Nil
Hydrogen ion	7.9	8.3	7.5	9.0	6.7
Free carbon dioxide	1.0	0.0	3.0	0.0	.....
Oxygen consumed	23.9	9.5	7.1	.....	4.4
Oxygen dissolved	7.0	8.2	5.7	.....	.....
Evaporated residue	273	239	216	102	148
Manganese	0.15	0.05	Nil	Nil	.....
Iron	0.80	0.20	0.10	Trace	0.10
Calcium	42.80	43.10	42.80	11.60	9.70
Magnesium	14.23	16.60	16.55	7.17	5.24
Sodium and potassium	11.88	7.68	6.67	6.74	.....
Chlorides	2.25	2.50	3.50	3.00	1.75
Sulphur	7.73	6.51	10.58	9.09	1.37
Temporary hardness	146	166	151	40	40
Permanent hardness	23	13	27	21	12
Total hardness	169	179	178	61	52

variables. The amount of water per capita consumed where soap is required is somewhat indefinite but for this estimate was taken as 1,000 g.p.d. per capita per year. The cost of soap varies but in this case was assumed as 20c per pound. The St. Paul water department supplies water to 300,000 people, therefore the requirement for softened water is 300 m.g. per year, or 3½ per cent of the water consumed. A reduction of 118 p.p.m. of calcium carbonate hardness is equivalent to a reduction of 6 lb. of sodium stearate (soap) per 1,000 gal. of water, but commercial soaps are neither 100 per cent pure nor composed entirely of sodium stearate. However, a reduction in the soap consumption of 6 lb. per capita per year would result in a saving to the community of $360,000 per year. The additional cost for water softening treatment as applied to the year 1937 would amount to $48,000 per year. The value to the community of softening the Mississippi River water would be $312,000 per annum.

The writer is indebted to the St. Paul Board of Water Commissioners and Leonard N. Thompson, general superintendent, for the use of the above data.

Welded Diagonal Grid Framework

ANANT H. PANDYA and R. J. FOWLER

Engineers, Diagrid Structures Ltd., London

Contents in Brief — Structural shapes welded into a diamond-grid pattern to form a rigid continuous framework for roofs and floors have been used with considerable economy in England. Both plane and spatial grids are possible, the latter spanning large areas. This article is an abstract of a paper on the framing, known as "diagonal grid," which won the second grand prize in the James F. Lincoln Arc Welding Foundation contest.

THE PLANE AND SPATIAL GRIDS that form the subject of this paper are statically indeterminate systems whose advantage lies in the fact that the continuity or "monolithic action" of the members causes appreciable reduction in moments and forces acting on the framework. The plane grid, suitable for floors and flat roofs, is the more simple, but spatial structures represent merely an extension of the principle of the flat grid.

Plane grids

A plane grid is essentially a diagonal system of beams, usually having the same cross-section, which are arranged in two parallel sets, equally spaced and intersecting at 90 deg., and rigidly welded at the junctions or nodes. In such a layout the beams are of different spans and would, therefore, have different rigidities if treated as independent of one another. When connected monolithically, however, those more rigid give relief to those more flexible, and thus tend to equalize the moments and shear forces on all.

For single bays, the sides forming the boundaries can be divided into 2, 3, 4, 5 or even 6 equal parts, the aim always being to provide short corner beams (beam 1 in Fig. 2) and an angle of intersection as near to 90 deg. as possible. Sides of square bays, however, are usually divided into three equal parts, which has been found to be most economical in practice.

In continuous grids, which are merely a series of single bays, there is a marked similarity to concrete flat slab construction. This is accentuated by the fact that a set of crossed cantilevers is used at each column, which may be said to be comparable to concrete drop panels and column heads. Carrying the analogy farther, the grid beams themselves are similar to the two-way reinforcement of the concrete slab.

Fig. 2 (left) illustrates a typical diagonal grid bay supported on walls, columns or main beams along the boundaries only. It will be seen in Fig. 2 (right) that all the grid beams are subjected to moments and shears which tend to attain a uniform maximum value, thus illustrating the true cooperative action between the members. It will also be noted that, for any given layout, the actual spans

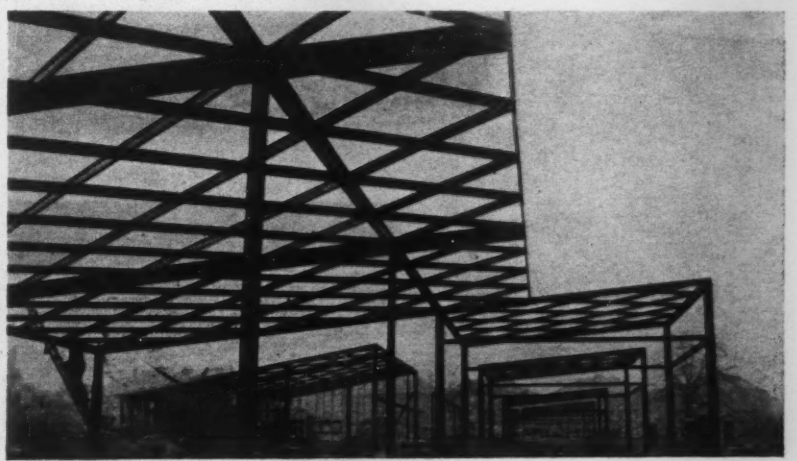


Fig. 1. A plane grid roof on a Manchester school with the bays supported at their corners on steel columns. Cantilever canopies are also a feature of this building.

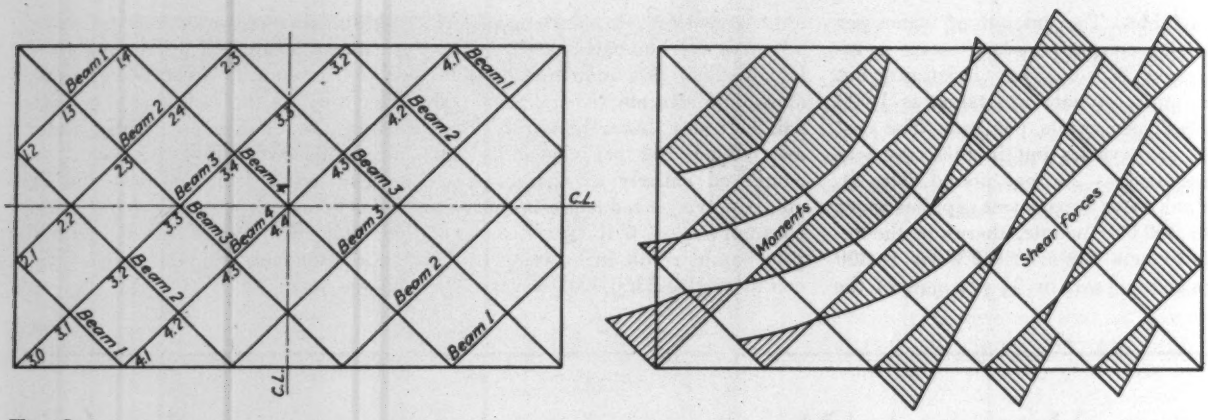


Fig. 2. Diagonal grid frames involve two sets of parallel beams at right angles to one another and arc-welded at the intersections. Moments and shears in such a continuous system are sketched at the right.

and loading can be varied without the necessity of a new calculation. This leads directly to the possibility of achieving standardization of calculations which are independent of the variables, span and load, and which, once made, can be applied to a variety of conditions. Furthermore, the selection of the size of grid beams can also be made in a few minutes from the maximum moment factor for a given layout.

Spatial or folded grids

For roof spans exceeding 50 ft., it is common in normal design to make use of space frames, arches, trusses, etc. With the diagonal grids the same results can be achieved by folding a plane grid to form a ridge along the centerline; horizontal ties are used between the eaves points at the ends of such pitched roofs. Such a folded grid, instead of being made up of interlacing beams, consists of a number of cranked beams that are fully continuous at the cranking points and are capable of transmitting moments from one side of the crank to the other.

Cranking or folding the plane grid introduces virtual elastic supports for grid members at ridge nodes which are, in their nature, similar to internal equalizing forces acting upward on the grid beams and downward on the inclined lattice or rhombic girders formed by the grid beams and ridge and eaves members. These imaginary supporting forces reduce the moments and shear forces on the grid beams very considerably and transfer the superimposed loads to the actual points of supports along the boundaries by means of direct forces in the members.

Spatial grids, that is folded or curved grids, can embrace almost any size or shape of roof structure. The effect of folding is to stiffen the monolithic plane grid along ridge and valley lines. This removes many of the restrictions on the grid layout and makes it possible to span distances up to 300 ft. in the shorter direction (parallel to ridge and valley lines) and almost unlimited distances in the other direction.

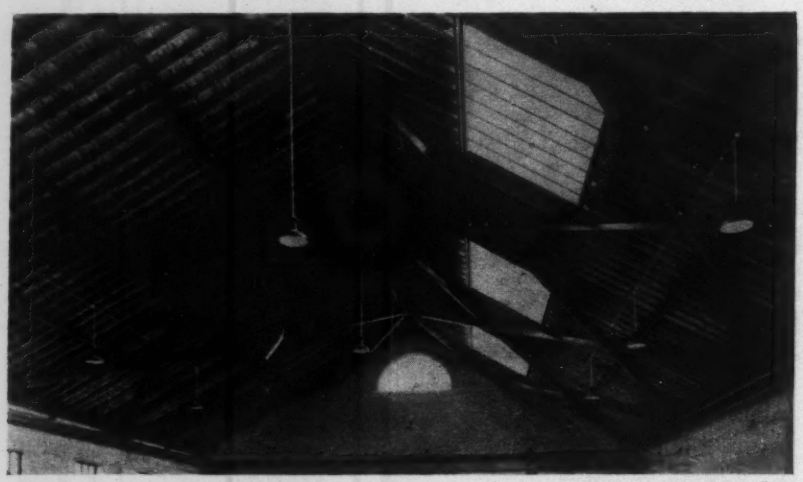


Fig. 3. Pitched roof grid on Blackpool ice rink. Such grids are merely plane grids folded along the ridge line.

Some diagonal grid buildings

A number of buildings have been built in England that utilize the diagonal grid framework. For example, in a factory in Bristol, about two dozen 20-ft. square grid panels are supported on two rows of columns; the grids were considered continuous in one direction and were designed for a live load of 100 lb. per sq.ft. In an open-air school in Manchester, 11 plane grid roof panels of varying sizes are bolted to steel columns at the panel corners; the largest panel is about 27 ft. square. These are both plane grids, but on a drill hall in London, a single pitch roof 82 by 52 ft. in plan is used, supported on concrete edge beams at eaves level while, for an ice rink at Blackpool, a similar roof spans 135 ft. and covers a building 150 ft. long.

Fabrication and erection

On all of these structures much of the fabrication was done at the site with gas torches and arc-welding machines. At the intersection points the beams are notched halfway through so that they will fit together, and then are welded to achieve complete continuity through the intersection. Large panels of grids are completed on the ground and then lifted into place on the columns or wall supports. Both fabrication and erection thus are relatively simple.

FIG. 1. DREDGE CUTTING AWAY A BANK OF SILT IN THE DESILTING BASIN OF THE COLUMBUS PROJECT

Engineering Problems of Nebraska Power

V. T. BOUGHTON

Managing Editor, Engineering News-Record

Contents in Brief—Engineering and construction difficulties of the first two public power developments in Nebraska are outlined and the manner in which that experience is being used to advantage on the project now under construction is described. This article supplements one on Nebraska power developments published in the April 27 issue.

SEEPAGE, bank slumping and ice were the chief sources of early trouble in Nebraska's water power developments that were described in the issue of April 27, p. 546. They still are major sources of trouble, but the engineers are confident that their worst troubles are behind them and that such as remain can be eliminated. Silt was expected to be a big source of trouble on the Columbus project, but due to the success of the silt handling facilities put in when that project was built, silt disposal has become largely a matter of routine.

Sutherland project

The Sutherland project of the Platte Valley Public Power & Irrigation District was the first to be built. Its supply canal (Fig. 2) takes water from behind a diversion weir across the North Platte near Keystone, carries the water through a winding canal of 1,750 sec.-ft. capacity along the south side of the valley, then through a cut 140 ft. deep to a 7,400-ft. concrete siphon 14 ft. in diameter which crosses under the South Platte at Paxton. The siphon discharges into an open canal in the hills to the south of the river which carries the water east again to Sutherland reservoir, a total distance of 32.3 miles. The reservoir is a basin of 175,000 acre-ft. capacity formed by rolled fill dikes. It was designed for a drawdown of 55 ft., that depth being used to store floodwaters to supplement the limited supply of irrigators taking water from the river below the confluence of the North and South Platte.

From the reservoir a canal of 1,400 sec.-ft. capacity, 19.2 miles long, leads to a smaller regulating reservoir from which water is drawn for the Platte Valley power plant where an average head of 204 ft. is developed by two hydro-electric units of 13,000 kw. capacity. Below the power plant a 2½-mile tailrace returns the water to the river below the town of North Platte. Thus the water taken out at the diversion dam travels about 55 miles through canals and reservoirs before it is returned to the river.

One of the obvious difficulties of this long canal system is the light and porous nature of the soil through which the canals were to be built. the canals were too long to be lined throughout, hence seepage losses were expected to be large during the early period of operation, and slumping of banks at some points was anticipated. In sections where physical conditions called for a slope steeper than 1 on 1½, the canal was lined; in the other sections it was hoped that deposits of the fine silt carried by the river would reduce seepage losses to a negligible quantity within a few years after putting the project into service.

Troubles develop

The project went into service in December, 1935, in a limited way to season the canals and reservoirs, but it soon had to be closed down due to partial failure of the drop structure in which water from the supply canals goes down into the Sutherland reservoir. During the three following years the project was out of operation most of the time due to numerous troubles, including two breaks in the siphon under the South Platte River, difficulties with ice in the canal and at the control structures, and seepage from the canal in regions where it is built above ground.

Ice troubles in the supply canal were due chiefly to the rapid changes

that occur in the rate of flow of the North Platte River in winter when practically the whole volume of the river is diverted into the canal. Thus it often happens that a flow of 1,500 sec.-ft. drops to 200 sec.-ft in two or three hours, and increases occur just as rapidly. Without control of the water level in the canal, ice that formed on the surface would drop to the bottom of the canal. The ice in falling pulled loose much of the 2-in. shotcrete lining in the lined sections. With an increase in flow it was picked up and carried downstream to form ice jams.

Caused Paxton failure

It was such a jam that was responsible for the failure of the Paxton siphon on Feb. 3, 1937. Ice, piling up behind a control structure, caused a surge that overtopped the banks at the south end of the siphon scouring out the bank, undermining the siphon and causing the collapse of its southern end. This break was repaired and the system put into operation again on March 3, only to have the southern end of the siphon collapse again on March 30. The cause of the second collapse never was definitely fixed, there having been no ice in the canal and no abnormal hydraulic conditions. One theory put forward is that a large quantity of ice from the initial break fell into the hole scoured under the outlet end of the siphon, was buried there by the wash from the siphon, and was not discovered when the hole was refilled. Melting of this ice with the warmer weather resulted in settlement and collapse of the siphon.

The original control structures consisted of a series of openings about 6 ft. wide in which operators could place stoplogs to keep the water surface nearly constant. As the piers between these openings checked the movement of ice they have been removed and levels now are maintained by the use of hand-operated steel gates placed in the wider openings.

In places where the canal banks have slumped badly the slope has been reduced from 1 on 1½ to 1 on 2, curves have been protected against erosion by a gravel blanket and where bad seepage developed clay blankets have been placed. Silt deposits are slowly reducing the minor seepage losses.

The damaged 2-in. shotcrete lining has been replaced with thicker slabs of concrete poured in place on the canal slopes.

Seepage from reservoir

The high embankments forming Sutherland reservoir were built of carefully controlled rolled fill and were lined with concrete, but seepage developed when filling of the reservoir began. It was of such magnitude as to interfere with cultivation of land below the reservoir, hence the reservoir never has been filled to within 30 ft. of its top.

Silting of the reservoir bottom is slowly checking the seepage. When visited this spring, the flow from under the main embankment amounted to about 2 sec.-ft.

Seepage may yet add materially to the cost of these projects as the state supreme court recently upheld an award of $7,100 damage to a farmer whose land was put out of use by seepage from the Sutherland reservoir.

Diversion of water into Sutherland reservoir was resumed in November, 1938, and the power plant was put into operation in December of that year. Production of commercial power was begun in February of this year and has been uninterrupted since then despite partial failure of the lining of the stilling basin at the outlet of Sutherland reservoir late in March. The lining has been repaired temporarily.

Loup River silt

Silt has long been recognized as a major obstacle to the development of power on the Loup River because the stream carries from .05 to 2.0 per cent of silt and it is planned to use almost the entire flow during periods of low water.

The Columbus project of the Loup River Public Power District consists of a low diversion dam and skimming weir about 5½ miles above the town of Genoa, a desilting basin 200 ft. wide, 10,000 ft. long and 16 ft. deep and a second skimming weir

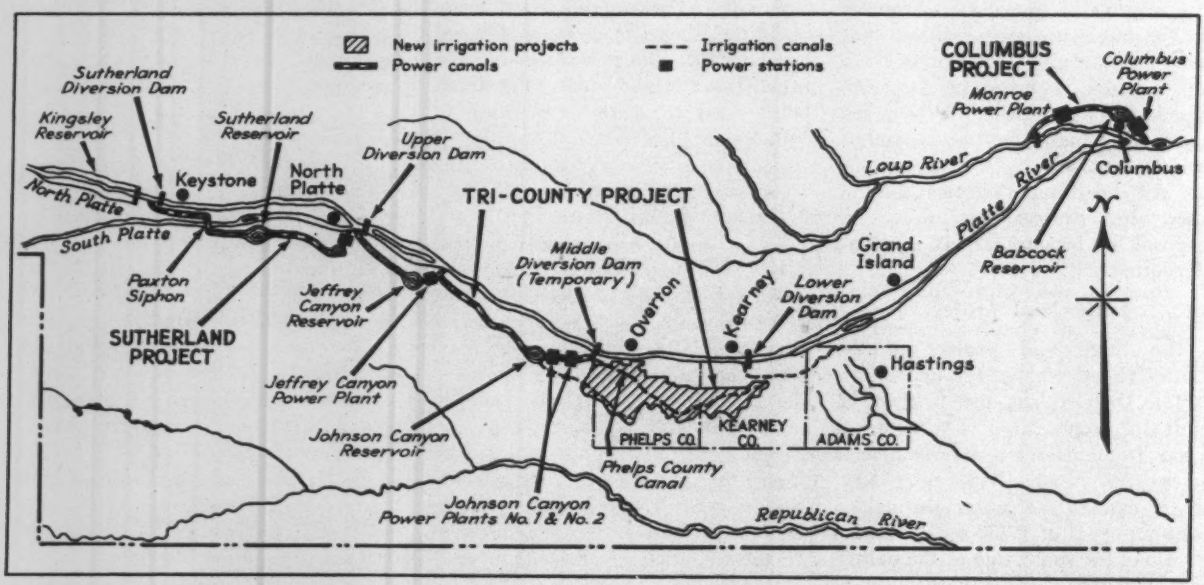


Fig. 2. The Sutherland and Columbus projects are completed and in operation. Construction work on the Tri-County project is well along. Kingsley reservoir will provide storage for that project.

at its lower end from which a canal 11½ miles long and having a capacity of 3,000 sec.-ft. extends to a power station just north of the town of Monroe. This station contains three hydro-electric units of 3,200 hp. each developing a head of 32 ft. From this plant the low-line canal extends 13 miles to a regulating reservoir 3 miles north of Columbus having a total capacity of 11,000 acre-ft. of which 6,000 acre-ft. is usable for power generation. A supply canal 1½ miles long and having a capacity of 4,800 sec.-ft. extends from the reservoir to the Columbus power station, which contains three hydro-electric units of 18,000 hp. capacity each. Below this station a tailrace 5½ miles long carries the water to the Platte River just below the confluence of the Platte and the Loup.

Water is drawn into the Loup River over a long skimming weir along the north bank of the river. This provides the first step in the desilting operation. Sluice gates in the main river weir at the lower end of the skimming weir make it possible to flush silt from in front of the skimmer. The second and final stage of desilting is in the long stilling basin, which, according to the first plans approved by the PWA, was to be equipped with a dredge mounted on a gantry spanning the basin and capable of traveling its full length. This dredge was to pump silt from any point in the basin to a concrete and steel flume on the river side of the basin which would discharge it along the river bank below the dam at points where it would be carried away during high water. As now operated, a 28-in. floating dredge of the "dust pan" type has been substituted for the gantry dredge. A flexible discharge line carries the dredged material to the flume, but at the present time it is being discharged over the bank to fill low land along the river.

Present practice is to operate the dredge from March to December on one eight-hour shift per day. This is with a diversion of about 600 sec.-ft., or about one-quarter of the proposed rate of 2,400 sec.-ft. when the power plant is up to capacity. Pumping 65 cu.ft. per sec., the dredge removes about 1,200 cu.yd. per hour. As power is used during off-peak periods, the cost, based on a plant output of 200,000,000 kwh., is about $0.00054 per kwh.

Fig. 3. By its form this weir at the inlet to the Babcock reservoir of the Columbus project maintains a very uniform level in the tailrace of the Monroe power station and at the same time is freed of ice troubles.

To date the much-discussed silt problem of this project has given the operators little trouble. Samples taken from the canal below the desilting basin have a silt content of one-tenth of one per cent.

Ice piled up in front of the intake last November and for a time reduced the amount of water that could be taken in. However, it did not cause a complete shutdown of the plant. An ice boom was installed in December and no further ice trouble developed.

Little trouble has been experienced with the canals of the Columbus project. Learning from the difficulties of the Sutherland project, the engineers made the canal slopes flatter and avoided sharp changes which would disturb the ice cover. The results so far have been very satisfactory.

Seepage losses

A major problem in the operation of the Columbus project is seepage in areas below the regulating reservoir back of Columbus, and at some points below the supply canal. Parts of the canal system have been in service now for three years. In these sections the seepage has reduced materially each year and little further trouble is anticipated. Borrowpits that were full of water at first are now dry and some meadows that were too wet for crops the first year were used for crops last year. Water has been in the reservoir for two years but has been maintained at a low level to minimize seepage losses. About 1,000 acres of land in areas lying to the north and south of the reservoir have been affected by seepage, but here also the blanketing of the reservoir bottom with fine silt is materially reducing the seepage loss. Much of the area affected had little natural drainage. A drainage ditch, cut by the district, has materially helped the situation and little trouble is anticipated during the growing season this year. Farmers whose lands are put out of production are paid on the basis of what the land would have produced in good years, which has been a very satisfactory arrangement for the farmers in the past two dry seasons.

Lessons put to use

Lessons learned on the Sutherland and Columbus projects are being put to use on the Tri-County project, now under construction. Most notable is the location of the canals far enough back into the hills to get the flow line below natural ground level, thus avoiding the long wet embankments of the Sutherland project that resulted from efforts to do the work at the lowest possible cost.

By carrying the canal back into

the hills it has been found possible to use natural valleys for considerable lengths of the canal, closing off the lower end of valleys with a dam, taking the local drainage into the canal, and cutting through to an adjoining valley at the upper end. Flumes and siphons have been avoided wherever possible as they are sure to cause rise or fall in the water surface of such long canals as are required for that project. Control structures have been designed to present the least possible resistance to the movement of ice that may be freed in the canal. The natural stilling basins where valleys are used for the canal are expected to be useful in controlling ice.

Engineering

In the previous article the economic aspects of these power and irrigation projects were discussed. The projects also are interesting from an engineering angle as demonstrating what can be done in developing power on rivers having as flat slopes as the Platte and the Loup, and as showing the pitfalls to be avoided. Much has been said about the engineering mistake and failure of structures during the early stage of this work. Even those most directly concerned are frank to admit that mistakes were made, but they were due almost entirely to the speed that was demanded by the PWA in order to get the work under way and to the consequent lack of adequate knowledge of underground conditions, soil behavior and the like. Preliminary designs had to be hastily made and yet could not be extravagant on the side of conservatism because it was known from the start that costs would be high at best.

Taken as a whole, the engineering work has been skillfully done and there are many ingenious examples of doing what engineers are supposed to do, make a dollar go farther than it would in the hands of untrained men. Skillful planning of the grading and earth handling operation has resulted in remarkably low bids for the vast amount of earth moving involved in the Tri-County project.

One fact that impresses the outsider visiting the project is the extent to which the engineering work now is being directed by local men. In the past, Nebraska had few engineering projects, hence it was to be expected that outside engineering talent would be brought in on these large projects when they were first begun. Thus the firm of Parsons, Klapp, Brinckerhoff & Douglas of New York was engaged for the Sutherland project and the Harza Engineering Co. of Chicago was engaged to handle the engineering work of the Columbus project. But now the engineering is largely in the hands of native Nebraskans. Hence the engineering set-up also serves to emphasize the local character of the undertaking as contrasted with the TVA where all the money and most of the engineering talent has been and still is imported.

On the two projects that have passed from the construction to the operating stage, I. B. Jones, long associated with irrigation work in the arid West, is now in charge of civil engineering work of the Sutherland project and Fred C. Albert, a native Nebraskan is in charge at Columbus. On the Tri-County project the engineering has been chiefly local since its start, but the district staff has had the advice of the Fargo Engineering Co., of Jackson, Mich., and numerous consulting engineers in special fields. George E. Johnson, former state engineer of Nebraska is chief engineer and general manager, and R. O. Green is assistant chief engineer in charge of the field work. George N. Carter is resident engineer at Kingsley Dam, D. A. Buzzell was hydraulic engineer until a few weeks ago, W. J. Turnbull is soils engineer and I. W. Barber is materials engineer. On the electrical side, E. E. Chilberg is electrical engineer, and Andrew McCall is resident engineer in charge of power-house construction. Johnson, Green, Turnbull, Carter and Buzzell all are men who gained part of their engineering training in Nebraska.

Grass Filters For Sewage Treatment

A GRASS SEWAGE FILTER, one of the few of its kind in the country, is being built at the Wellington, Ohio, sewage treatment plant. This innovation was introduced from England some ten years ago and is expected to be particularly useful in the operation of small plants. The following information is from the U. S. Works Progress Administration which is making the installation in Ohio.

The method of operation is to run the effluent over a sodded area after it has come from the settling tanks and before it is finally discharged into a stream. The grass in effect strains the solid matter from the liquid as it passes through it, the blades of grass catching the solid particles and leaving the liquid effluent clearer than before it entered the filter area.

Any kind of tough grass may be used for the filter, such as beach grass or some similar type that will grow in sand and water. The filter, for successful operation, must be designed with underdrains so that the flow which will pass downward can be drained from the bottom. This is essential because it is necessary to mow the grass several times during the summer months to prevent it from growing too long. When excessive length is attained, the blades fall over and become matted.

According to the WPA report, George B. Gascoigne and Associates, consulting sanitary engineers of Cleveland, stated: "We consider the use of grass filters particularly applicable for the small plant handling domestic sewage, where a clear effluent is desirable. Grass filters add relatively little to the overall degree of purification, but very much to the appearance of the final effluent."

Mr. Gascoigne introduced this type of sewage filter to the United States about ten years ago after seeing the successful operation of such a filter at Birmingham, England.

Prior to the construction of the Wellington grass filter by the WPA, similar filters had been satisfactorily operated at Medina, Ohio; New Wilmington, Pa., and Meadville, Pa. A new plant at Geneva, Ohio, is being equipped for the same type of sewage treatment. (*See also p. 80, this issue*)

BOOK NOTES AND REVIEWS

The month's additions to the engineer's reading and reference list

Elementary Estimating

HOW TO ESTIMATE FOR THE BUILDING TRADES—By Gilbert Townsend, J. Ralph Dalzell and James McKinney. 629 pp. Published by American Technical Society, Chicago. Price $4.75.

Most books on estimating for building construction assume that the reader knows something of the art of building, take a knowledge of certain fundamentals for granted, and consequently serve as a guide for the more experienced estimator. In this volume, however, the authors assume nothing in the way of knowledge of either construction or estimating processes. They take the reader by the hand and lead him through the simple elementary fundamentals such as how to figure the area of plane surfaces, the volume of rooms, how to use architects' and engineers' scales, how to read plans and how to study specifications.

Furthermore, the authors soundly contend that the embryo estimator must visualize how the various parts and elements of a building are formed and fit together before the labor and material requirements and resulting costs can be figured. Consequently, the book portrays each and every step in building procedure in the most minute detail. The theme of the book is estimating the cost of a certain house, for which full specifications are given, accompanied by eight large drawings printed in blueprint blue for effect.

Because it is so elementary, this work fills the present void at the bottom of the list of estimating literature.

Cooperating subcontractors have contributed cost data based on their own experience for reference. These data are broken down into labor and material components, from which costs that meet local conditions can be estimated. Complete check lists are also included.

While the scope of the book does not extend beyond house and small building construction, the estimating principles revealed are applicable to larger and more complicated structures. Along with each step required in building the theme house are given several common variations of procedure likely to be encountered on similar operations.

Analysis of Dams

STATICA DELLA DIGHE—Parte I, Dighe a gravita. By Oscar Hoffman. 128 pp. Published by Ulrico Hoepli, Milan, Italy. Price, 16 lire.

In this little book the author treats the analysis of gravity dams using exclusively the mathematical theory of elasticity. The classical theories as well as the more recent advances on the subject are explained in a lucid and systematic manner. However, some contributions to the analysis of gravity dams have been overlooked by the author. In spite of the inherent difficulties of the subject, the book is easily read by those with a knowledge of Italian and will be found especially valuable to the practicing engineers desiring to extend their knowledge into the realm of the most advanced theories. To a full understanding of the book a thorough knowledge of the calculus is essential.—*Reviewed by* A. FLORIS, *Los Angeles, Calif.*

Earthquake Data

EARTHQUAKES OF THE PACIFIC COAST of the United States, 1769-1928, a Descriptive Catalogue—By Sidney D. Townley and Maxwell W. Allen. Published by the Seismological Society of America, Bacon Hall, University of California, Berkeley, Calif. Price $2.

A knowledge of the historical record of earthquakes is valuable to those interested in the earthquake hazard and earthquake-resistant design. In 1898, Prof. E. W. Holden published the first "Catalogue of Earthquakes of the Pacific Coast from 1769-1897." This work has been out of print for many years in spite of a continuing demand. Some years ago, Prof. S. D. Townley of Stanford University and Maxwell W. Allen undertook the task of revising and correcting Holden's work, and extending it to 1928. This work is now completed and has been published as a bulletin of the Seismological Society of America. Those interested will find it of great value in arriving at a correct appraisal of the extent and severity of the earthquake hazard on the Pacific Coast, including California, Washington, Oregon, Idaho, Utah, Arizona and Nevada—*Reviewed by* H. M. ENGLE.

MISCELLANEOUS NOTES ON BOOKLETS AND REPRINTS

A BIBLIOGRAPHY of articles relating to the non-technical aspects of engineering education has been published by Cooper Union, New York, as Engineering and Science Series No. 18.

REVISED STATUTES relating to water, water supplies and sewerage systems in New Jersey are contained in Circular 213, issued by the New Jersey Department of Health, Trenton, N. J.

A.S.T.M. STANDARDS ON CEMENT, covering specifications, chemical analysis and physical tests, has been published in pamphlet form by the American Society for Testing Materials, 1260 Broad St., Philadelphia, Pa. Price, $1 (members, 75¢.).

STANDARD SPECIFICATIONS for portland cement concrete pavement and for sewers have been issued by the American Public Works Association as Section F and Section J of Standard Specifications for Public Works Construction. The specifications are being published in loose-leaf form for insertion in a binder available from the association.

THE HIGHWAY, THE MOTOR VEHICLE AND THE COMMUNITY is the subject of a pamphlet published by the National Highway Users Conference, National Press Building, Washington, D. C., which is a case study of a number of instances in which abandonment of railroad lines has made it necessary for the highway of the region to take over all the transportation service to the isolated communities.

TRANSIT INSTRUMENTS were the subject of two investigations made last year at the University of Illinois (Urbana) and reported in Bulletin

(*Continued on p. 82*)

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

Flange Angles for Hoppers

HERBERT SIMON
Department of Public Affairs, Newark, N. J.

A formula for calculating the flange angles in a steel hopper having the shape of an inverted right pyramid of four sides was published by the writer in "From Field and Office" (*ENR* March 31, 1938). Delving further into the subject I derived a formula applicable to a right pyramid of any given number of equal sides.

In the original problem, the flange angle required was the supplement of one half of the interior angle formed by the planes of two adjacent sides, measured at right angles to their line of intersection. The new general formula is:

$$\tan\beta = \frac{\sqrt{1 + \tan^2\phi \cos^2\alpha}}{\tan\phi \sin\alpha}$$

in which

β = ½ the interior angle formed by two adjacent sides, measured at right angles to their line of intersection.

ϕ = the angle that each side makes with the horizontal and $\alpha = \frac{180°}{n}$

wherein n = number of sides of the pyramid.

The exterior flange angle required is then $180° - \beta$

In a pyramid of four sides, $n = 4$ and α becomes 45°. The equation then resolves itself into

$$\tan\beta = \frac{\sqrt{2 + \tan^2\phi}}{\tan\phi}$$

which is the formula originally submitted.

This formula, although it plays no part in the actual theoretical design of a hopper, is valuable and a great time saver in the preparation of shop drawing details.

• • •

Truck-Mounted Drill Rig

A combined foundation drilling and testing rig has been built by the California Division of Highways on the chassis of a 5-ton, 4-wheel-drive truck, as shown in the accompanying illustration. The unit is demountable and can be taken from the truck for use on a barge or on skids. A light V-8 motor supplies power for drilling through a 5-speed transmission. The derrick has a 32-ft. mast designed for a 30-ton pull; it can be swung forward to a horizontal position over the truck cab when the rig is to be moved.

Frequent assignments for this outfit are drilling holes 20 to 48 in. in diameter with a rotary drill rig whose table projects from the rear end. These holes are for visual inspection of underground strata and for locating slip planes. A churn drill operated with the aid of the derrick is used for harder materials. Equipment for sampling and testing soils and foundation materials generally is also carried.

• • •

Influence Line Short Cut

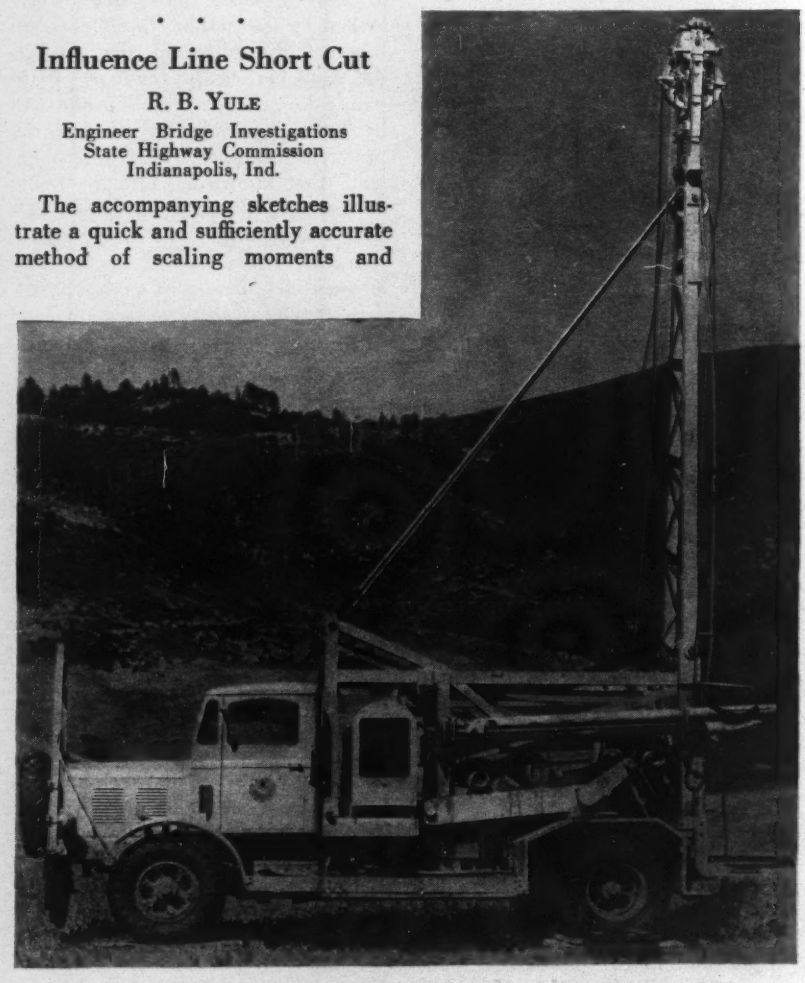
R. B. YULE
Engineer Bridge Investigations
State Highway Commission
Indianapolis, Ind.

The accompanying sketches illustrate a quick and sufficiently accurate method of scaling moments and shears from influence diagrams when a series of unequal concentrated loads, such as truck axle loads, are involved.

In a strength survey when the effect of several different truck loadings, based on actual trucks in service, must be investigated, the influence line method for obtaining maximum moments and shears is desirable as axle load position and direction of travel for a maximum can usually be determined by inspection or a quick side computation using the criterion method.

The influence lines having been drawn and the axle loads spotted, each ordinate must be scaled, multiplied by the corresponding axle load and all then added together for the total.

This work has been shortened by using quadruled computation paper on which to draw the influence lines (*A*) and a card, on whose edge has been marked the position of the truck



Truck mounted outfit for drilling foundation test holes.

axle loads (*B*) to the same scale as the truss. Each truck is drawn proceeding from right to left and left to right with the axle loads shown in pounds. Also a line sketch as illustrated is used in which the distance between the flaring lines (*C*) is always proportional to each axle load divided by 10,000.

The axle positions on the influence line base line are spotted by transfer from the truck card which has been shifted along the base line to the position to give a maximum. A narrow strip of paper with a straight edge (*D*) is then marked with a starting point at the upper left corner. The length of the first ordinate *a-b*, is transferred to the edge of the strip and multiplied graphically on the flaring line diagram. In turn each ordinate, such as *c-d*, *e-f*, *g-h*, is added and multiplied graphically. When all have been transferred to the strip, the total distance is scaled and multiplied by 10,000 and the scale factor to obtain the required maximum moment or shear.

Using quadruled paper, it is not necessary to draw the ordinates, obtaining a normal to the base line by paralleling the ruling of the paper. When the shear computation involves a negative ordinate, it can be subtracted on the strip as easily as added. In practice the scales are made as large as 8½x11-in. paper will permit or when a larger scale is advisable, cross-section paper can be used to fold to the 8½x11-in. size for binding.

Surprisingly accurate results can be obtained by this method, even with small scales. In this instance with a horizontal scale of 1 in. = 15 ft. and a vertical scale of 1 in. = 0.5 lb. by scale the shear is 22,900 lb. and by exact computation 22,964 lb. In a moment case with a scale of 1 in. = 15 ft., the corresponding figures were 919,500 ft. lb. and 924,000 ft. lb.

A COLD-WEATHER ASPHALT KETTLE

A portable asphalt kettle has been designed by the California Division of Highways for use in the winter season or in the cold temperature of high altitudes. A 300-gal. kettle is sheathed with sheet iron spaced 2 in. from the inner drum shell. An adequate heating torch is installed to keep the contents of the tank hot while the rig is towed some distance from the supply base. With this rig, asphalt mixtures can be used for winter repairs that previously could not be made conveniently.

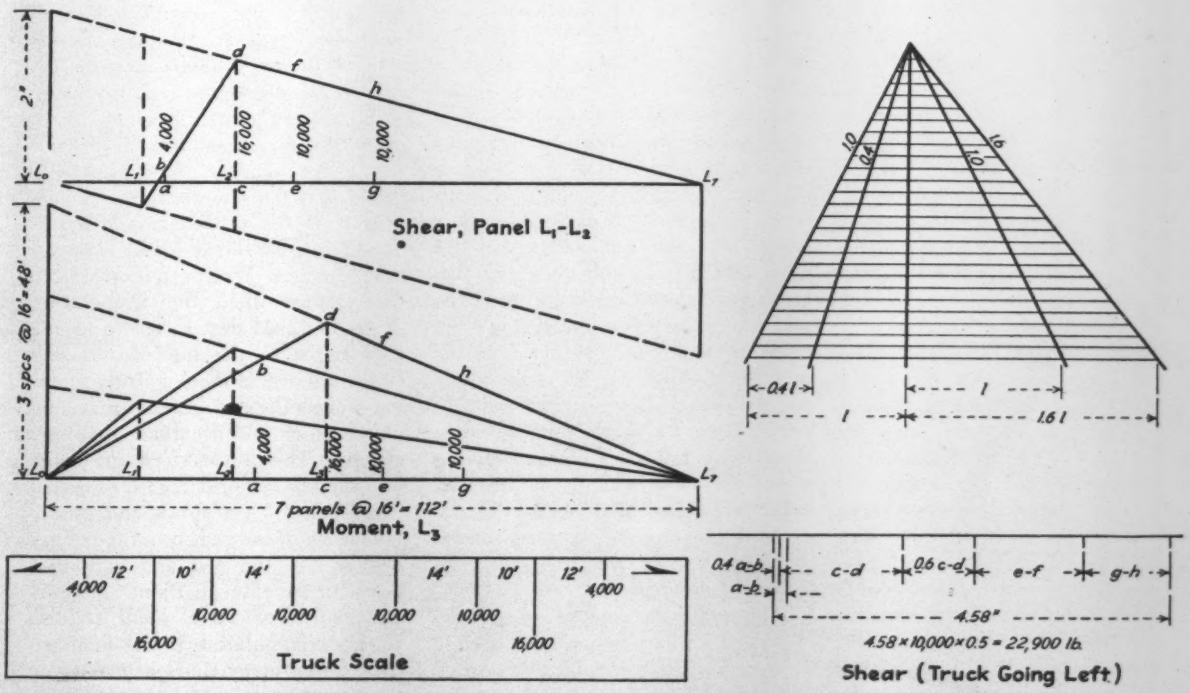


Chart for scaling moments and shears from influence diagrams when unequal concentrated loads are involved.

Notes on Sewage Disposal

A monthly summary of current developments conducted by Willem Rudolfs

GRASS FILTERS—Attention has been called to the effectiveness of grass filters as an adjunct to sewage purification (*ENR*, Jan. 6, 1938, p. 32, and p. 76 of this issue). It is now learned that Melbourne, Australia, has in operation some 967 acres of grass filters. Effluent from settling tanks flows through graded bays 33 ft. wide and not less than 1,200 ft. long which are sown with Italian rye. Any herbage which will thrive under swampy conditions throughout the winter months appears to be suitable. Best results, however, are obtained with a native buttonweed (*Cotula coronopifoli*) which soon establishes itself. Borrie (*Journal* Inst. Eng., Australia, Oct., 1938) shows the effect of new and well-established grass filtration areas as follows:

	Settled effluent	Effluent new area	Effluent old area
Sus. solids, p.p.m.	164	34.8	5.2
Ammonia, "	40.1	26.0	31.6
Nitrates, "	0	....	1.7
B.O.D., "	363.7	27.2	17.8

This method of treatment is normally used from April to September inclusive, since it is successful only as long as a vigorous growth can be maintained. With warmer weather the herbage begins to die and the effluent deteriorates. On well-established areas the grass reseeds itself. Uniform continuous loading of 1 m.g.d. per 20-24 acres is practiced. No odor or other nuisances are created.

BIOLOGICAL ACTIVITIES—The view held by many that the upper limit in biological treatment has not been reached appears to have received considerable substantiation by the publication of recent results obtained from trickling filters. There has been much speculation on why high-rate trickling filters could produce substantially the same results as low-rate filters when properly operated. Sohler (*Gesundheits Ingenieur*, Dec. 31, 1938) describing results obtained with high-rate applications to filters which previously had been in operation for a number of years as low-rate filters (with the only difference that the sewage was better distributed), gives a few results on number of anaerobic and aerobic bacteria present in the effluents. The averaged results were per cc. in 48 hr. at 22 deg. C.:

	Low-rate	High-rate
Aerobic	141,000	3,300,000
Anaerobic	44,750	191,000

It would seem that with increased food supply, caused by increasing the dosage 6 times, the number of aerobic organisms increased over 20 times and the anaerobic organisms about 4½ times. Since the aerobic organisms are presumably of greater importance it becomes a question to determine how the proportion of organisms should be increased in relation to dosage.

AIR PRESSURE EFFECTS—Remarkable results have been obtained in activated sludge treatment using only one-third or one-fourth the quantity of air usually considered necessary for the production of a good effluent. The question of increasing the pressure of air has been investigated from time to time but the results achieved were not much different from those obtained with lower pressures. Hicks (*The Surveyor*, Nov. 25, and Dec. 23, 1938) described a pilot plant where five tanks were placed vertically in a tier; air was initially supplied to these tanks at a pressure higher than atmospheric. Applying 1.3 cu.ft. of air per gallon of sewage he was able to purify from 3 to 4 times more sewage than in a full-scale plant receiving about the same amount of air. Calculations show that with the increased pressure the average saturation of oxygen was increased by about 10 per cent.

Although the amount of oxygen dissolved in the water was not greatly in excess of that dissolved at normal pressure, Hicks claims that it is this small amount of super-saturation which does the extra work. By applying higher air pressures about three times the normal sludge concentration can be maintained. There is little doubt that the higher sludge concentration plays an important role in producing purified effluents in a shorter time.

The fact that the sewage could be purified with a relatively lower air consumption and in a shorter time by the use of five-tier apparatus as compared with conventional aeration tanks is of considerable importance from the standpoint of design. The possibility of progressive re-use of air in five tanks with a ratio of surface area to volume (10:1) the same as in most plants operating in England, allowing the air bubbles to pass through the sewage more effectively, seems worthy of further study.

WORMS IN FILTERS—It is well known that a small springtail insect (*Achorutes Viaticus*) is capable of keeping trickling filters open, resulting in less filter fly niusance. The groups of organisms present in a filter bed are interdependent; if one group is absent, others (fungi and algae) increase rapidly and may cause choking and ponding, or may result in decreased nitrification. Under normal operation conditions, without overloading, there is a rather definite relationship between the bacteria, microscopic plants and small animals. In this community small reddish brown worms (*Lumbricillus Lineatus*) about 15 mm. long and 1.25 mm. in dia. appear to be of considerable importance. Reynoldson (*The Surveyor*, Feb. 17, 1939) found that the abundance and localization of the worms in the bed is definitely correlated with temperature changes. Worms migrate from the surface when the temperature drops to 42–44 deg. F. but in spring they move to the top of the bed. In the absence of these actively scouring worms the bed gradually accumulates solids and eventually becomes clogged. The worms feed primarily on surface growth; cold weather causes them to go down and should unloading of the beds occur they bury deeply into the bed and may pass out with the effluent. Plant operators frequently see these small reddish worms accumulating in the final settling tanks, many times in masses on the liquid surface.

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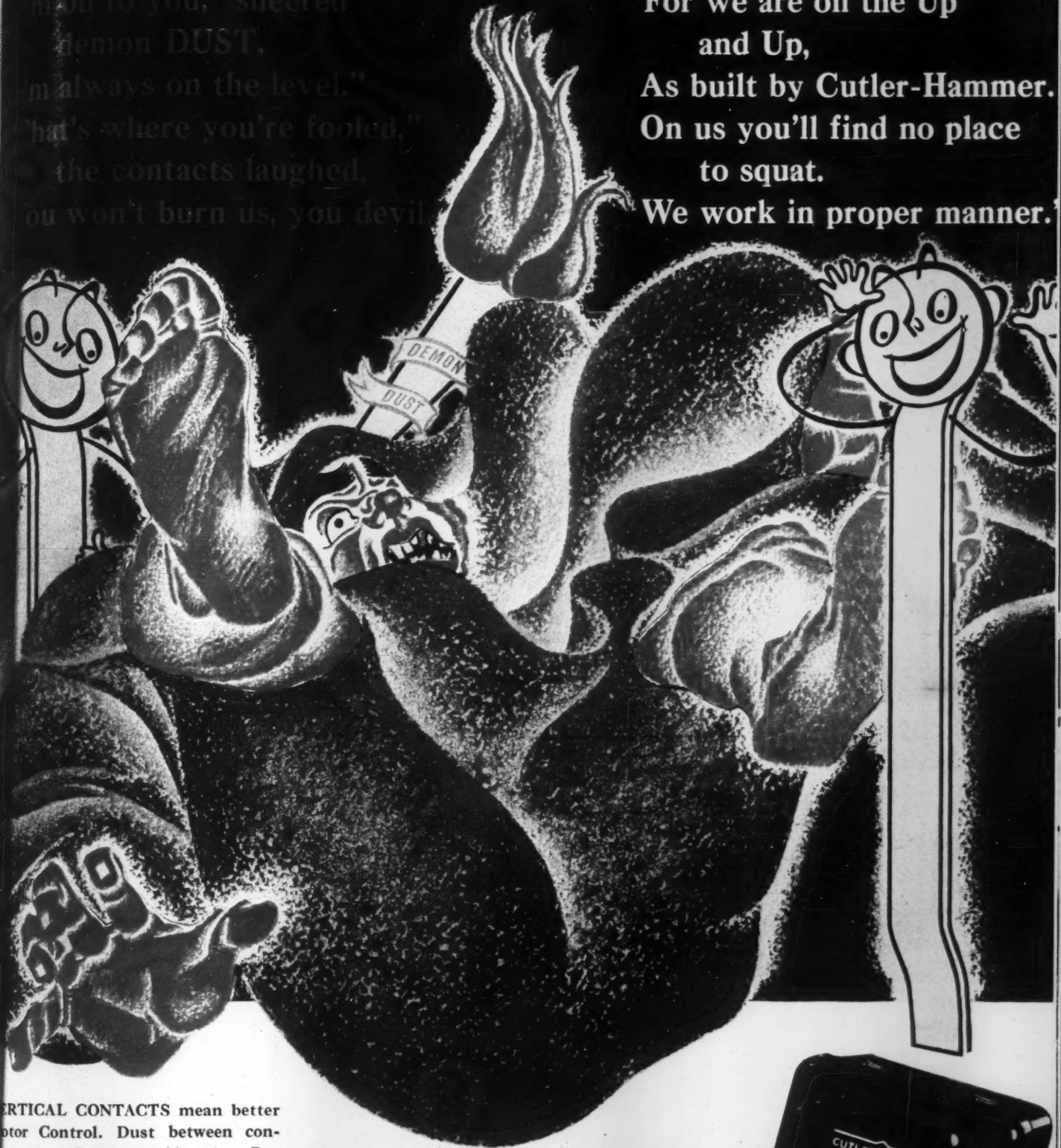

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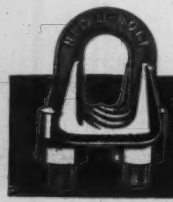

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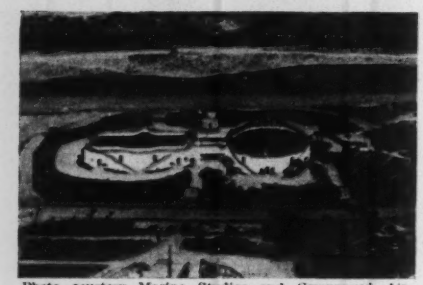

Photo courtesy Marine Studios and Compressed Air Magazine

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MISCELLANEOUS NOTES ON BOOKLETS AND REPRINTS

(*Continued from p. 77*)

No. 75 under the title of "Two Investigations of Transit Instruments." The first investigation related to verniers with the purpose of determining the effect of size and accuracy of workmanship on the accuracy of readings. The second study was made to determine the importance of the relation between the line of sight and the axis of the objective slide. It was found that except for very accurate surveys the effect of wear in the objective slide is negligible. Workmanship was found to be important in verniers.

FINANCING OF SEWERAGE WORK, with particular reference to financing through sewer rental, is discussed in a 22-page publication of the Portland Cement Association. The booklet includes a discussion of the various types of financing available, procedures which have been found valuable in financing projects, the full text of a typical revenue bond ordinance, and an interesting table showing the method used and the results obtained with sewer rentals by a large number of communities throughout the country. The booklet may be obtained from the association at 33 West Grand Ave., Chicago.

TESTS OF GAS MASKS for the use of operators handling chlorine at water purification plants made under the direction of the city engineer, Chicago, have been summarized in pamphlet form and may be obtained from the Efficiency Division, Bureau of Engineering, Department of Public Works, Chicago.

NEW PUBLICATIONS

ARC WELDING IN DESIGN, MANUFACTURE AND CONSTRUCTION—Published by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio. 1,408 pp. Price $1.50 in U. S.; $2 elsewhere.

HOUSING FOR THE MACHINE AGE—By Clarence Arthur Perry. Published by Russell Sage Foundation, New York. 261 pp. Price $2.50.

ELASTICITY—PART III, THERMOELASTICITY—By C. A. P. Turner. Published by the author, 22 E. Gay St. Columbus, O. 240 pp. Price $5.

1938 PROCEEDINGS OF THE INSTITUTE OF TRAFFIC ENGINEERS—May be obtained from the Office of the Secretary, 60 John St., New York City. 105 pp. Price $1.10.

PUBLIC ADMINISTRATION ORGANIZATIONS—Fourth Edition, 1938-39. Published by Public Administration Clearing House, 1313 E. 60th St., Chicago, Ill. 183 pp. Price $1.50.

THE MUNICIPAL YEAR BOOK 1939—International City Managers' Association, 1313 E 60th St., Chicago, Ill. 586 pp. Price $5.

PROCEEDINGS OF HIGHWAY RESEARCH BOARD 1938, Part I—May be obtained from Highway Research Board, Washington, D. C. 405 pp.

PIPING HANDBOOK—By J. H. Walker and Sabin Crocker. Third Edition. Published by McGraw-Hill Book Co., New York and London. 897 pp. Price $6.

AMERICAN ARMIES AND BATTLEFIELDS IN EUROPE—Prepared by American Battle Monuments Commission. Published by the Superintendent of Documents, Government Printing Office, Washington, D. C. 547 pp. Price $2.75.

BRITISH WAGES BOARDS—By Dorothy Sells. Published by The Brookings Institution, Washington, D. C. 389 pp. Price $3.

PROCEEDINGS OF THE PUNJAB ENGINEERING CONGRESS—1938, Vol. XXVI. Edited by members of the Council. May be obtained from The Punjab Engineering Congress, P.W.D. Secretariat, Lahore, India.

SOLS ET FONDATIONS—By Armand Mayer. 198 pp. Published by Armand Colin, 103, Boulevard Saint-Michel, Paris. Price 15 fr. (paper; 17 fr. 50, bound).

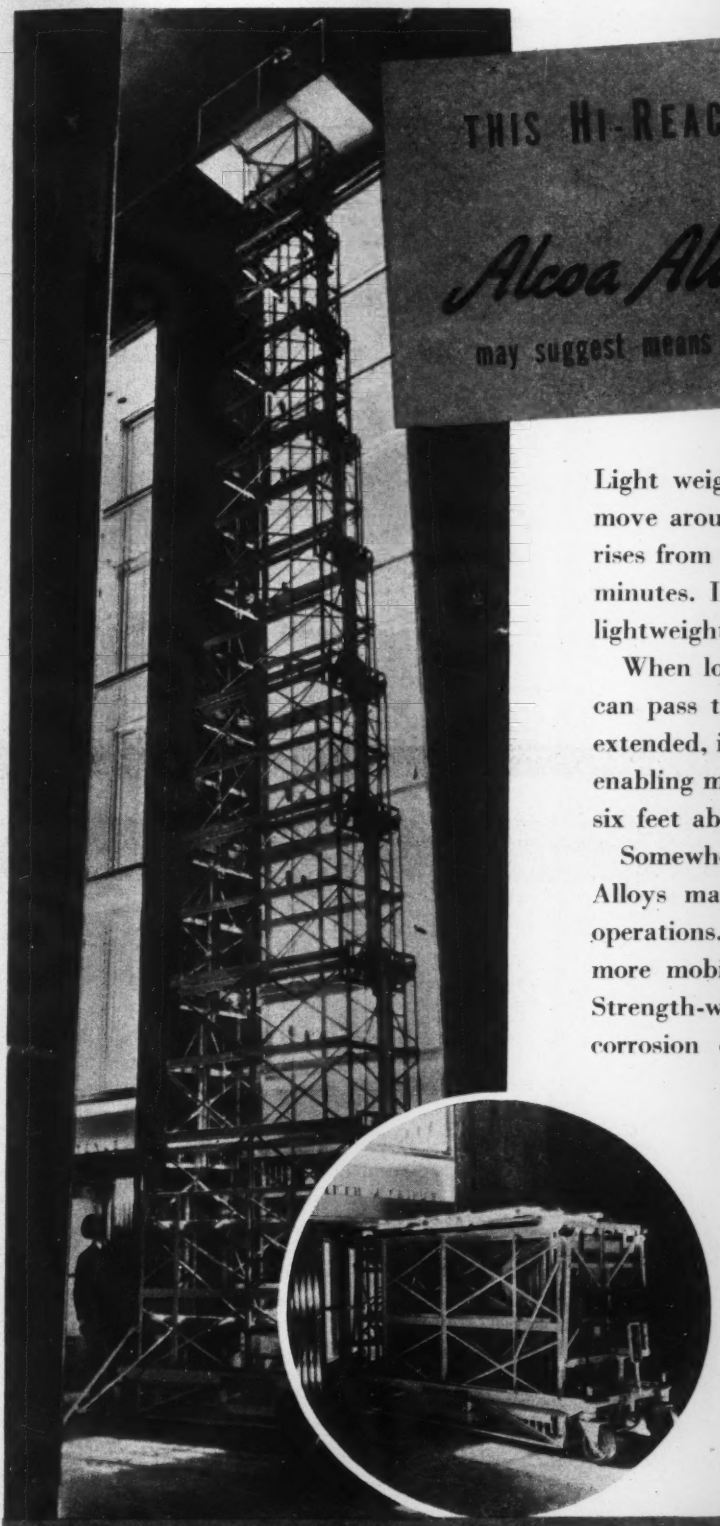
REPORTS AND PAMPHLETS

RESOURCES AND PLANNING—A series of pamphlets by the National Resources Committee under the titles: Technology and Planning; Planning Our Resources; Federal Relations to Research; Population Problems; The States and Planning; Regional Planning; Our Cities; and Water Planning. 10¢ each from the Superintendent of Documents, Washington, D. C.

HARTFORD, CONN.—Thirty-first Annual Report of the Department of Engineering, 1938.

PROPERTIES OF COMPOSITE BEAMS, Consisting of Steel Joists Encased in Concrete, under Direct and Sustained Loading—A Reprint from the Journal of The Institution of Civil Engineers, London. Session 1938-39.

(*Continued on p. 107*)



THIS HI-REACH TELESCOPING TOWER made of Alcoa Aluminum Alloys may suggest means of improving your mobile equipment

Light weight makes this Hi-Reach tower easy to move around. Powered only by a 1-Hp. motor, it rises from seven feet to a height of 49 feet in eight minutes. Its nine telescoping sections are made of lightweight Alcoa Aluminum Alloys.

When lowered, this tower is so compact that it can pass through the doors of the building. Fully extended, it has high strength and perfect stability, enabling men to work in safety at the ceiling, fifty-six feet above floor level.

Somewhere in your processes, Alcoa Aluminum Alloys may help increase the efficiency of your operations. Their lighter weight makes equipment more mobile, lessens loads on driving apparatus. Strength-weight ratios are high. Resistance to corrosion offered by Aluminum makes it long-lived and protects product quality.

Our engineers will gladly assist in determining the facts. ALUMINUM COMPANY OF AMERICA, 2108 Gulf Building, Pittsburgh, Pennsylvania.

• • •

49-foot telescoping Hi-Reach tower at work in the International Building, Rockefeller Center, New York City.

ALCOA ALUMINUM

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

HIGHWAY BRIDGE, WASHINGTON

OWNER: Washington State Highway Department; L. V. Murrow, director.

PROJECT: Construction of Crosby River bridge and approaches in Renton, King County. Total length 0.125 mi., including a steel plate girder bridge 100 ft. long. Time for completion is 240 calendar days.

BIDS: Five bids were opened Apr. 11, 1939, ranging from the contract low of $85,941 to $111,455.

LOW BIDDERS:

1. David Nygren, Seattle (contract) $85,941
2. M. P. Butler, Seattle 96,260
3. Toney Romano, Seattle 97,575

APPROACHES

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Clear and grub	L.S.	$1,000	$1,000	$1,000
2. Unclass. excav	540 c. y.	.50	.75	1.00
3. Struct. excav	80 c. y.	1.00	1.50	1.50
4. Selected borrow	70 c. y.	1.00	1.00	2.00
5. Cr. stone surf., top course	40 c. y.	3.00	3.00	3.00
6. Grading parking strips	135 l. f.	.50	.25	.30
7. Conc. pavt. h.e.s cement	2,274 s. y.	3.00	3.20	2.85
8. Conc. bridge pavt. h.e.s. cement	67 c. y.	25.00	15.50	18.00
9. Reinf. type No. 2	11,500 lb.	.05	.055	.055
10. Dowel bars, rubber caps	655 ea.	.25	.25	.25
11. Dowel bars without caps	1,267 ea.	.20	.15	.20
12. Integral concrete curb	277 l. f.	.50	.50	.35
13. Special concrete curb	55 l. f.	1.00	1.00	1.00
14. Conc. sidewalk h.e.s. cement	198 s. y.	2.00	1.75	2.00
15. Conc. sidewalk, integral curb, h.e.s. cement	15 c. y.	30.00	20.00	27.00
16. Reinf. steel	2,000 lb.	.05	.055	.05
17. Conc. driveways, h.e.s. cem.	226 s. y.	3.00	3.50	2.50
18. Conc. Federal air markers	1 ea.	10.00	10.00	10.00
19. Adjusting catch basin	1 ea.	20.00	30.00	15.00
20. Remove exist. conc. pavt.	1,582 s. y.	.50	.50	.50
21. Remove exist. conc. curb	373 l. f.	.10	.30	.30
22. Remove exist. conc. sidew.	320 s. y.	.20	.40	.25
23. Remove, reset lamp posts	3 ea.	50.00	175.00	30.00
24. Remove, reset c. i. inlets	5 ea.	20.00	20.00	20.00
25. Remove, relay pkwy. cable	330 l. f.	.50	.60	.20
26. Remove, relay 10-in. sewer pipe	L.S.	50.00	90.00	100.00
27. Relay 8-in. conc. pipe	20 l. f.	.50	.80	1.00
28. 6-in. Conc. or vit. sewer pipe	180 l. f.	.75	1.00	.60
BRIDGE				
29. Struct. excav	915 c. y.	6.00	6.00	7.00
30. Concrete, class A	350 c. y.	25.00	27.00	28.00
31. Concrete, class B	460 c. y.	25.00	27.00	27.00
32. Concrete, class D	204 c. y.	25.00	25.00	24.00
33. Reinf. conc. rail	309 l. f.	4.00	4.00	4.00
34. Reinf. steel	126,000 lb.	.05	.055	.05
35. Struct. silicon steel	171,000 lb.	.07	.085	.0875
36. Struct. carbon steel	137,000 lb.	.06	.08	.08
37. Cast steel	4,600 lb.	.15	.20	.20
38. Cast steel drains	14 ea.	25.00	25.00	25.00
39. Copper seals	61 lb.	1.00	1.00	1.00
40. Timber	64.3 M fbm	50.00	57.00	55.00
41. Furnish. creo. wood piling	1,540 l. f.	.60	.65	.65
42. Drive wood piles	44 ea.	12.00	15.00	15.00
43. Furnish, drive wood test piles	1 ea.	100.00	200.00	100.00
44. Furnish, wood trestle piles	860 l. f.	.15	.15	.15
45. Drive wood testle piles	36 ea.	12.00	12.00	12.00
46. Lighting system	L.S.	1,500.00	1,750.00	1,600.00
47. Remove exist. structure	L.S.	5,000.00	6,000.00	8,000.00

SEWER, INDIANA

OWNER: City of Fort Wayne, Ind.; Charles W. Cole, South Bend, engineer.

PROJECT: Constructing Wayne St. section main intercepting sewer, including mechanical equipment for sewers. Tunnel is to be of concrete, monolithically cast, and of a semi-elliptical cross section. Stipulated contract time is 350 days. Transportation by rail and highway is available. Fifty per cent of the job is in water bearing sand, which will necessitate construction under compressed air.

BIDS: Five bids were received Apr. 18, 1939, ranging from the contract low of $866,538 to $1,195,847. Minimum labor rates are as follows: skilled, $1.50 per hr.; semi-skilled, 90 c. per hr.; common, 60 c. per hr.

LOW BIDDERS:

1. Gargaro Co. Inc., Detroit, Mich (contract) .. $866,538
2. Cooke Contracting Co., Detroit 1,092,277
3. Underground Construction Co., Chicago 1,133,624

Item	Quan.	Unit Prices (1)	(2)	(3)
1. 66-in. Semi-ellip. tunnel	7,760 l. f.	$36.75	$54.00	$51.75
2. 84-in. Semi-ellip. tunnel	9,308 l. f.	56.00	64.50	69.00
3. Std. manholes 15 ft	23 ea.	115.00	150.00	245.00
4. Add'l ht. manholes	667 l. f.	12.00	10.00	25.00
5. 24-in. Pipe tunnel sewer	556 l. f.	15.00	20.00	28.00
6. Special manhole	L.S.	800.00	450.00	1,231.00
7. 12-in. Vit. tile sewer	206 l. f.	3.00	4.00	8.00
8. 15-in. Vit. tile sewer	264 l. f.	2.80	4.50	8.00
9. 18-in Std. vit. culvert pipe	330 l. f.	4.60	6.00	10.00
10. 6-in. Vit. tile house conn	4 ea.	8.75	50.00	80.00
11. Std. manholes 6 ft	4 ea.	55.00	75.00	100.00
12. Add'l. ht. manholes	32 l. f.	7.50	12.00	15.00
13. Regulator and appur	L.S.	10,500.00	13,300.00	11,156.00
14. Regulator and appur	L.S.	5,000.00	5,500.00	5,125.00
15. Regulator and appur	L.S.	5,600.00	7,500.00	7,874.00
16. Regulator and appur	L.S.	5,000.00	6,000.00	6,494.00
17. Regulator and appur	L.S.	5,000.00	6,500.00	5,392.00
18. Jct. chamber	L.S.	2,200.00	3,000.00	2,521.00
19. Asph. pav't repl	286 s. y.	5.00	4.00	4.00
20. Conc. asph. pav. repl	45 s. y.	2.50	4.50	4.00
21. Brick pav. & repl	7 s. y.	4.00	10.00	6.00
22. Gravel repl	65 s. y.	1.00	1.00	2.20
23. Align shaft	672 l. f.	3.00	4.50	3.50

STREETS, CALIF.

OWNER: City of San Francisco; J. J. Casey, city engineer.

PROJECT: Two contracts covering grading and asphaltic concrete paving on Junipero Serra Boulevard between St. Francis Circle and county line, and on Alemany Boulevard between Ocean Ave. and Seneca St.

BIDS: Five bids were received on each project Apr. 12, 1939. The Junipero Serra bids range from the contract low of $17,217 to $20,187, and the Alemany Boulevard bids range from the contract low of $21,879 to $24,744. Labor rates range from 75¢ to $2.00 per hr.

LOW BIDDERS: (Junipero Serra)

1. Eaton & Smith, San Francisco (contract) $17,217
2. C. L. Harney, San Francisco 17,394
3. Fay Improvement Co., San Francisco 17,785

(Alemany Boulevard)

1. Fay Improvement Co. (contract) $21,879
2. Eaton & Smith 23,420
3. C. L. Harney 23,529

JUNIPERO SERRA

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Excavation	1,650 c. y.	$.25	$.30	$.60
2. Reset armored conc. curb	620 l. f.	.20	.20	.23
3. Conc. sidewalk	1,920 s. f.	.15	.13	.135
4. Asph. conc. pave., 8- and 2-in. courses	63,000 s. f.	.245	.249	.25
5. Asph. conc. binder course	85 ton	4.00	4.00	3.23
6. Asph. conc. wearing surface	95 ton	5.00	4.00	3.47
7. Plant ice plants	2,100 s. f.	.01	.01	.01
8. Multiple curb inlet	1 ea.	125.00	100.00	21.00
ALEMANY BLVD.				
1. Excavation	2,600 c. y.	.30	.40	.30
2. Asph. conc. pave. 8- and 2-in courses	92,000 s. f.	.2265	.24	.244
3. Asph. conc. wearing surf	10 ton	3.00	6.00	5.00

(*Contract Unit Prices continued on second following page*)

THIS SAYS: "BETTER CONCRETE"

"BETTER cement makes better concrete," as the saying goes—and here is a typical example: Completion of Missouri Pacific tunnel, Gray Summit, Mo., built in 1929, determined date when new double-track cut-off, St. Louis to Jefferson City, could be placed in service.

Using 'Incor' 24-Hour Cement, one set of forms sufficed; the single form section was moved forward 12 to 24 hours after placing concrete; lining followed closely on drilling operations.

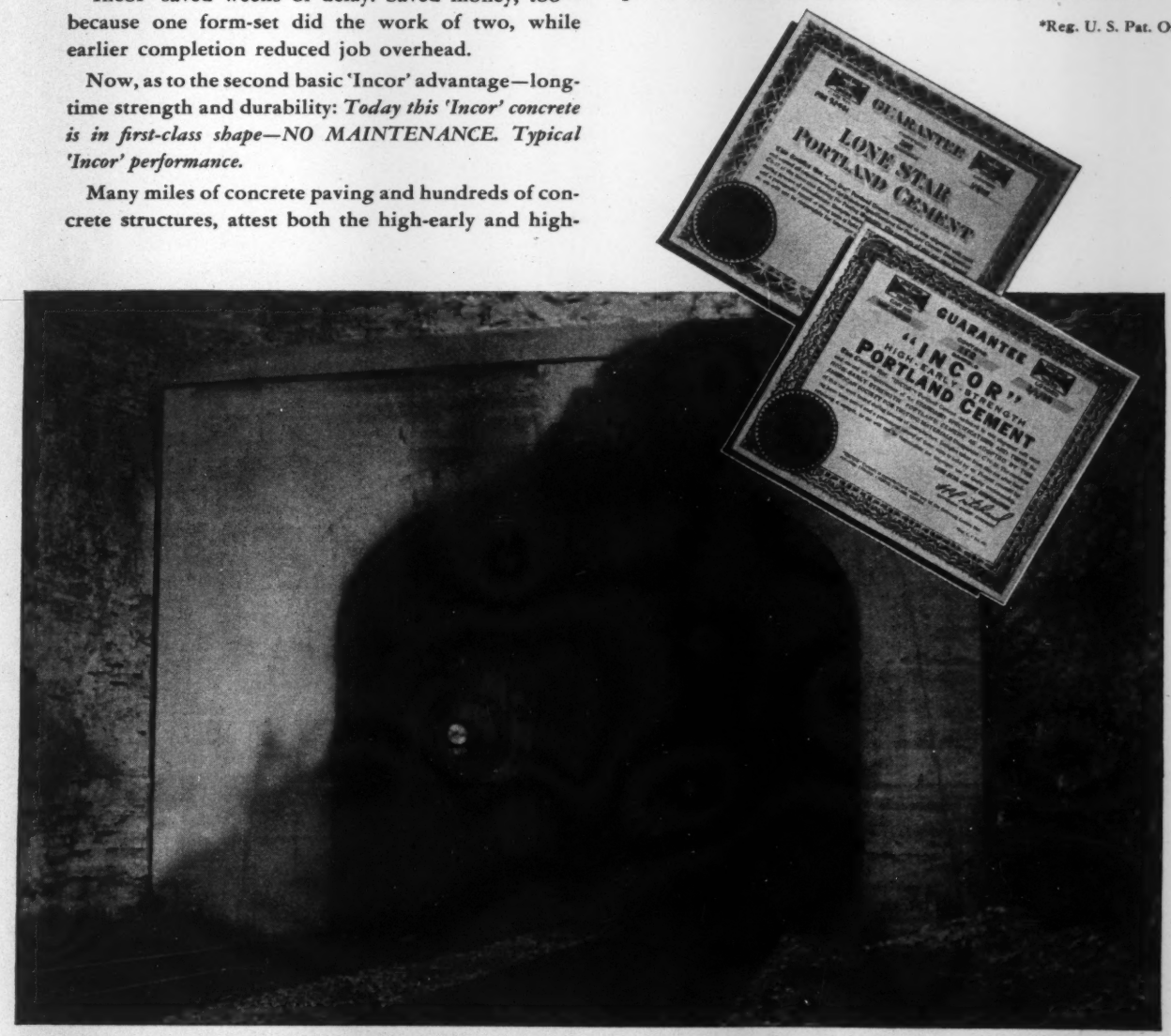
'Incor' saved weeks of delay. Saved money, too—because one form-set did the work of two, while earlier completion reduced job overhead.

Now, as to the second basic 'Incor' advantage—long-time strength and durability: *Today this 'Incor' concrete is in first-class shape—NO MAINTENANCE. Typical 'Incor' performance.*

Many miles of concrete paving and hundreds of concrete structures, attest both the high-early and high-ultimate quality of this improved Portland cement—prove that 'Incor' is producing the same kind of high-quality concrete that skilled contractors have been making with Lone Star Cement ever since 1900.

For behind 'Incor'* stands Lone Star's 39-year record for unvarying quality and uniformity. Use 'Incor' where high-early strength and faster job curing show you a profit—elsewhere use Lone Star. Quality-guarantee certificate with every shipment. Write for book . . . "Cutting Concrete Costs." Lone Star Cement Corporation, Room 2280, 342 Madison Ave., New York.

*Reg. U. S. Pat. Off.



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Sales Offices: ALBANY, BIRMINGHAM, BOSTON, CHICAGO, DALLAS, HOUSTON, INDIANAPOLIS, JACKSON, MISS., KANSAS CITY, NEW ORLEANS, NEW YORK, NORFOLK, PHILADELPHIA, ST. LOUIS, WASHINGTON, D. C.

(Contract Unit Prices continued from page 84)

POTOMAC RIVER BRIDGE

OWNER: Maryland State Roads Commission.

PROJECT: Construction of a bridge across the Potomac River between Ludlow Ferry, Va. and Charles County, Md. This contract (No. 2) includes the west abutment, approach trestle bents Nos. 1 to 59 and piers Nos. 1 to 20. Total length of approach fills and bridge for the completed project is 11,369 ft. Bridge proper is 10,050 ft. Longest span is 800 ft. and the pile trestle at the west end is 3,628 ft. long. Highest point on the roadway is to be 150 ft. above water. Stipulated contract time is 310 calendar days and transportation by rail, highway and water is available. Due to the condition of the river bottom, some steel piles will be driven 150 ft. to rock.

BIDS: Three bids were received Feb. 14, 1939, ranging from the contract low of $2,089,323 to $2,394,012. Wage rates are as follows: skilled $1.75 per hr.; semi-skilled, 90 c. per hr.; common 70 c. per hr.

LOW BIDDERS:

1. Merritt, Chapman & Scott, New York (contract) $2,089,323
2. Arundel Corp., Baltimore 2,272,372
3. Spencer & Ross, Detroit 2,394,012

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Dredging for piers 1 to 20	158,000 c. y.	$.55	$1.12	$1.00
2. Class 2 excav. west abut	70 c. y.	3.60	4.00	2.00
3. Class 3 excav west abut	20 c. y.	10.00	4.00	10.00
4. Wash borings, ord. dry samples	1,600 l. f.	3.00	4.50	4.00
5. Wash borings, undist. samples	1,600 l. f.	6.00	5.00	5.00
6. Undisturbed samples	125 ea.	9.00	3.00	10.00
7. Core borings	80 l. f.	4.50	6.00	10.00
8. Steel H piles 14x14½-in., 73 lb.*	1,500 l. f.	4.80	4.50	6.10
9. Steel H piles 14x14½-in., 89 lb.	1,600 l. f.	5.35	5.20	6.70
10. Steel H piles 14x16-in., 102 lb.	2,300 l. f.	6.10	6.00	7.40
11. Steel H piles 14x16-in., 117 lb.	1,600 l. f.	7.05	6.50	8.10
12. Steel H piles 14x14½-in., 127 lb.	825 l. f.	7.60	7.00	8.90
13. Steel H piles 14x14½-in., 136 lb.	840 l. f.	8.00	7.30	9.40
14. Steel H piles 14x16-in., 142 lb.	875 l. f.	8.20	7.60	9.60
15. Steel H piles 14x16-in., 158 lb.	900 l. f.	9.15	8.10	10.40
16. Steel H piles 14x16-in., 176 lb.	920 l. f.	10.00	9.00	11.50
17. Steel H piles 14x16-in., 102 lb.*	120,750 l. f.	5.38	7.00	6.40
18. Steel H piles 14x14½-in., 127 lb.	15,300 l. f.	6.68	7.60	7.50
19. Class A untr. wood piles	1,500 l. f.	.65	.90	1.40
20. Concrete test piles, ready for driving	800 l. f.	9.00	9.50	8.00
21. Driving conc. test piles	750 l. f.	3.70	3.00	5.60
22. Steel test piles, ready for driving	140,000 lb.	.045	.045	.044
23. Driving steel test piles	1,575 l. f.	2.20	2.00	3.50
24. Loading test piles	6 ea.	1,000.00	1,500.00	900.00
25. Platforms for survey sta	10 ea.	700.00	1,500.00	400.00
26. Tremie concrete	21,500 c. y.	31.15	22.80	30.40
27. Class A conc., Piers 1 to 20	6,900 c. y.	12.60	20.00	20.00
28. Class A conc., west abut	100 c. y.	22.00	25.00	26.00
29. Class A conc., trestle clamps	570 c. y.	23.50	35.00	34.00
30. Class A conc., trestle caps	630 c. y.	21.40	30.00	35.00
31. Reinf. steel, Piers 1 to 20	1,800,000 lb.	.063	.05	.06
32. Reinf. steel, west abut	6,100 lb.	.06	.05	.06
33. Reinf. st., trestle caps &clamps	95,000 lb.	.07	.05	.06
34. Steel prot. plates, Piers 1 to 20.	16,000 s. f.	2.30	5.00	1.80
35. Struct. steel and anchor bolts.	8,300 lb.	.35	.20	.15
36 Protec. coating for conc., west abut	L.S.	44.00	250.00	200.00
37. Facilities for engineers	L.S.	12,238.00	12,000.00	27,000.00

*Note — Items 8 to 16 are trestle bent piles; items 17 and 18 are pier piles.

GRADE SEPARATION, MICH.

OWNER: Michigan State Highway Department; Leroy C. Smith, engineer.

PROJECT: Construction of a grade separation between Inkster Road and Michigan Central Railroad at Inkster, Mich. A 59 ft. steel plate girder is to carry three tracks over the highway at a height of 14 ft. Underpass and approaches include 1,510 ft. of 42-ft. paving, with 6 ft. of sidewalk on each side. There are six girders in the bridge. Stipulated contract time is 200 calendar days and transportation by rail and highway is available. During construction, it is necessary to build a pedestrian detour, and falsework and trestles to provide uninterrupted traffic. Excavation is all in earth.

BIDS: Eight bids were received March 22, 1939, ranging from the contract low of $163,805 to $195,949. Wage rates are as follows: skilled, $1.50 per hr.; semi-skilled, $1.00 per hr.; common, 70 c. per hr.

LOW BIDDERS:

1. W. J. Storen Co., Detroit (contract) $163,805
2. L. A. Davidson, Lansing 176,079
3. Jutton-Kelly Co., Detroit 178,417

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Pedestrian detour	L.S.	$1,000.00	$725.00	$1,700.00
2. Break. exist. paving	3,400 s. y.	.10	.10	.10
3. Excavation and grading	44,200 c. y.	.50	.50	.50
4. Concrete in stairs	23.8 c. y.	30.00	25.00	36.00
5. Pipe handrail	87.5 l. f.	4.00	3.00	7.50
6. 24-in. reinf. concrete pipe	415 l. f.	3.50	4.50	4.25
7. 18-in reinf. concrete pipe	200 l. f.	2.65	3.00	2.55
8. 12-in reinf. concrete pipe	1,240 l. f.	1.65	1.75	1.65
9. 10-in storm sewer	947 l. f.	.90	1.25	1.00
10. 12-in sanitary sewer	1,846 l. f.	3.00	1.50	2.35
11. 8-in b&s sewer	477 l. f.	1.00	.80	.85
12. 6-in b&s sewer	27 l. f.	.75	1.00	.75
13. 6-in b&s open-joint sewer	2,442 l. f.	.75	.60	.70
14. 6-in. open-joint b&s sewer, slope drains, 3 ft. deep	1,800 l. f.	.55	.80	.65
15. 6-in. open-joint b&s sewer, slope drains, 3 to 6 ft. deep.	900 l. f.	.65	1.00	.75
16. 6-in. open-joint b&s sewer, slope drains, 6 to 9 ft. deep.	540 l. f.	1.27	1.40	.95
17. 6-in. open-joint b&s sewer, slope drains, 9 to 12 ft. deep.	360 l. f.	1.65	2.00	1.15
18. Manholes	17 ea.	115.00	75.00	80.00
19. Catchbasins	37 ea.	50.00	60.00	50.00
20. New manhole tops	9 ea.	15.00	20.00	15.00
21. New water mains complete	L.S.	11,000.00	18,500.00	13,500.00
22. 6-in. stone surf. on driveways	3,900 s. y.	.50	.65	.50
23. Slag base, paving and walks	870 c. y.	1.80	2.00	2.00
24. Conc. paving, 9-in	2,541 s. y.	1.90	1.80	1.80
25. Conc. paving, 10-in	8,941 s. y.	2.00	1.90	1.93
26. Concrete curb	5,110 l. f.	.80	1.00	.65
27. Concrete sidewalk, 4-in	26,300 s. f.	.16	.16	.14
28. Sodding	10,500 s. y.	.15	.20	.22
29. Seeding	3,600 s. y.	.22	.20	.05
30. Temporary railroad trestles, complete for three tracks	L.S.	18,910.00	20,800.00	19,750.00
31. Found. excav. below subgrade.	1,175 c. y.	1.60	2.00	3.00
32. Concrete abut. and wing walls	1,620 c. y.	13.00	14.00	18.00
33. Concrete bridge deck	113 c. y.	17.00	25.00	20.00
34. Rubbed surface finish	4,400 s. f.	.10	.10	.15
35. Reinf. steel	35.27 ton	70.00	90.00	80.00
36. Furnish. structural steel	167.65 ton	86.00	90.00	100.00
37. Unload and erect struc. steel.	167.65 ton	20.00	19.00	20.00
38. Steel bridge railing	L.S.	1,900.00	1,700.00	2,500.00
39. Membrane deck waterproofing	3,000 s. f.	.10	.10	.12
40. Mastic protective covering	2,060 s. f.	.30	.35	.35
41. Dampproofing backs abut. and walls	4,360 s. f.	.04	.05	.08
42. 8-in. corr. iron pipe	356 l. f.	1.20	1.25	1.50
43. Bridge lighting, cable pole to bridge lights	L.S.	800.00	500.00	838.00
44. Backfill	1,600 c.y	2.00	2.00	1.75

RETAINING WALL, MASS.

OWNER: City of Springfield, Mass.; C. W. Phillips, superintendent, Department of Streets and Engineering.

PROJECT: Excavation, installation of piles in preparation for construction by city of retaining walls for B.&A.R.R. Bridge approach on St. James Ave. Excavation is approximately 35 ft. long by 20 ft. wide.

BIDS: Five bids were received Mar. 13, 1939, ranging from $4,607 to $10,241. Stipulated contract time is two months. Transportation by rail and highway is available.

LOW BIDDERS:

1. Earle G. Sturtevant, Westfield, Mass. $4,607
2. F. T. Ley & Co., Inc., Springfield 6,500
3. James B. Rendle Co., Malden, Mass. 8,909

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Earth excav., sheeting, backfill	L.S.	$2,230.00	$4,129.00	$6,128.00
2. Rock excav	81 c. y.	2.50	6.00	3.00
3. Tr. timber piles	1,450 l. f.	1.50	1.30	1.75